RESEARCH REPORT 2023-2024
ON
POSTHARVEST TECHNOLOGY OF CROPS

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EFFICACY OF CLOVE ESSENTIAL OIL AND CARNAUBA WAX IN EXTENDING SHELF LIFE OF MANGO

M.M. RAHMAN, M.G.F. CHOWDHURY, M.H. H. KHAN

Abstract

The effects of clove essential oil, gibberellic acid and carnauba wax coating for controlling stem end rot and anthracnose caused by Botryodiplodia theobromae and Colletotrichum gloeosporioides, respectively of mango to extend the shelf life were investigated. Clove essential oil at 1 mlL^{-1} premixed with ethanol (1 mL L^{-1}) as stabilizer and Triton-X100 (40 mg L^{-1}) as surfactant in combination with carnauba wax has shown potential inhibition of the fungi with shelf life extension of mango.

Introduction

Mango (*Mangifera indica L.*) is one of the most important fruits and termed as the "King of fruits" in Bangladesh. It contains different phytochemicals and nutrients such as vitamin C, provitamin A, carotenoids, various polyphenols and dietary fibers. Recently in Bangladesh many entrepreneurs started to export mangoes in developed countries meeting the national demands but significant quantities are spoiled due to poor postharvest handling practices as well as microbial activities. Stem end rot and anthracnose caused by *Botryodiplodia theobromae* and *Colletotrichum gloeosporioides,* respectively have been reported to be the major postharvest fungal diseases causing substantial losses. Chemical fungicides are used for control despite health and environmental concerns. The constant use of synthetic fungicides also leads to development of resistant to the fungicides (Eckert et al., 1994). These have led to interest in finding natural plant compounds that have antifungal activity. The *in vivo* efficacy and practical applicability of only few of the essential oils (EO) have been studied (Rahman et al., 2022). Again, carnauba wax is a natural wax derived from the leaves of the carnauba palm, a Brazilian plant. It can be used to coat mangoes to slow down their water loss and respiration, and prolong their shelf-life.

Keeping all these information into consideration, the present investigation was proposed to investigate the essential oils of clove (*Syzygium aromaticum*) as botanical fungicides and carnouba wax in the management of stem end rot and anthracnose, and gibberellic acid (GA) as ethylene inhibitor to extend the shelf life of mango fruits.

Materials and Methods

Plant Materials

BARI Aam-3 (Amrapali) was collected from farmers' orchard in Naogaon District and transported to the laboratory of Postharvest Technology Division (PHTD), BARI. No fruits had been treated with a fungicide after harvest. Fruits were sanitized with calcinated calcium ($1gmL^{-1}$).

Laboratory Extraction of EO and Chemicals

Clove essential oil was extracted in the laboratory of PHTD using steam-distillation apparatus. Ethanol (Absolute GR, Merck), TritonX-100 and Calcinated calcium (EcoWash$^{@TM}$) was collected from Pioneer Scientific Store, Dhaka. Carnauba coating (Endura Fresh @TM 9000) was collected from USA. Carbendazim fungicide was purchased from local market.

Fruit Treatment

Surface sterilized fruits were arranged in rotating wax coating machine. Clove EO 1 mL L^{-1} premix with ethanol (1 mL L^{-1}) as stabilizer and Triton-X100 (40 mg L^{-1}) as surfactant was applied by hand spraying on the rotating fruits and at the same time Carnauba wax coating was also sprayed after the spraying of EO. Then, the treated fruits were placed in the plastic foam packaging cup liner and kept in 25℃. Fruits were also treated with GA (@400 ppm).

Statistical analysis

One-way ANOVA analysis was performed with Statistical Analysis System – version 9.4 (SAS Institute, USA) and where there was a significant difference between means, the LSD at p = 0.05 was calculated.

Results and Discussions

Clove EO extracted in the laboratory by steam-distillation method yielded approximately 5% oil. According to Ratri et al. (2020) eugenol (85%), caryophyllene (1.14%) and humulene (0.18%) are the main compounds in clove oil.

The mango treated with the combination of clove EO and carnauba was found to have highest shelf life (25% rotting) followed by the combination of GA (28% rotting) after storage of 14 days

(Table 1). The EOs treated mango also shows a better firmness and comparatively low TSS indicating its slow sugar conversion (Table 2).

Conclusions

This study implies that clove EO in combination with carnauba coating has potential to extend the shelf life of mango. To identify the exact causal component of clove EO for inhibiting stem end rot and anthracnose of mango the *in vitro* test and effect of temperature and relative humidity will be investigated next year.

Table 1. Rotting of mango following different postharvest treatments during storage at 25 °C

Treatments	Percent rotting	
	7 days	14 days
Control	21.67a	90.00a
Fungicide treated	20.00a	88.33a
Carnauba wax only	6.67b	80.00b
GA (Gibberellic Acid) only	1.67c	80.00b
Clove Essential Oil only	0.00c	55.00c
Clove EO + Carnauba wax	0.00c	25.00d
Clove EO + GA + Carnauba wax	0.00c	28.33d
Hot Water Treatment	3.33bc	51.67c
LSD[ǂ]	*4.10*	*7.40*

Values are the mean of 3 units of 25 fruits (1 batch x 3 replicates). [ǂ] Least significant difference between mean values in each column at $p = 0.05$.

Table 2. Firmness and TSS of mango following different postharvest treatments during storage at 24 °C

Treatments	Firmness (gf)			TSS (°Brix)		
	Initial	7 days	14 days	Initial	7 days	14 days
Control	5.40	2.90b	1.87c	17.73	22.2a	22.7a
Fungicide treated		3.53ab	1.93c		21.2ab	21.7b
Carnauba wax only		4.60ab	3.17ab		20.4bc	20.8c
GA (Gibberellic Acid) only		4.20ab	3.80b		18.1d	18.5e
Clove Essential Oil only		4.67ab	3.00ab		20.3bc	19.1d
Clove EO + Carnauba wax		4.87ab	3.27ab		19.3cd	18.4e
Clove EO + GA + Carnauba wax		5.37a	3.80a		19.8bcd	20.6c
Hot Water Treatment		4.77ab	2.20c		21.2ab	21.3b
LSD[ǂ]		*2.30*	*1.50*		*1.8*	*0.5*

Values are the mean of 3 units of 25 fruits (1 batch x 3 replicates). [ǂ] Least significant difference between mean values in each column at $p = 0.05$.

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SHELF-LIFE EXTENSION OF FRESH GUAVA FRUITS THROUGH POSTHARVEST TREATMENTS

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Abstract

The experiment was conducted to evaluate the effect of gibberellic acid and cling wrap packaging on the quality and shelf life of guava. Fruits pre-treated with gibberellic acid then packing with cling wrap gave comparatively acceptability quality and shelf life for 14 days of storage at 25° C.

Introduction

Guava (*Psidium guajava* L.) belongs to Myrtaceae family, a climacteric fruit (Akamine and Goo, 1979; Brown and Wills, 1983) that ripens rapidly. It is one of the most important fruits in tropical regions of the world. It is a delicious fruit with a high appreciated crispiness, which is rich in ascorbic acid and other nutrients (Leite et al., 2006). Guava fruit is perishable and becomes overripe rapidly under ambient condition (Mahajan et al., 2009). The climacteric identity of this fruit limits its postharvest life to 2–3 days at 25 °C, and keeping fruit in the storage at high temperature leads to increased activity of pathogenic fungi, respiration, high-ethylene production, weight loss and wrinkling of the fruit's skin surface. On the other side, low-temperature storage can cause chilling damage to the fruit (Ali et al., 1997; Murmu and Mishra, 2017).

The objective, therefore, is to determine combinations of postharvest treatments and cling wrap packaging that are effective for improving storage of guava fruit at room temperature.

Materials and Methods

Plant material

Commercial matured guava 'BARI Peyara-2' commonly known as "Thai Peyara" was obtained from local grower's orchard (Jhikargacha, Jessore, Bangladesh) and transported to the laboratory of PHTD, BARI, Gazipur. Each batch of fruit was randomly distributed into the required number of treatment units with 15 fruits per unit with three units/replicates assigned to each treatment. Each replicate was prepared and treated separately.

Fruit Treatment

The required number of fruits were dipped in gibberellic acid solution (@400 ppm) for 10 minutes. The control fruits were dipped only in water. After dipping all the fruits were kept on the table for 30 minutes for surface drying. Then, one group of the treated fruits were wraped with cling wraping cellofen and the other group kept unwraping. A group of non-dipping fruits also wraped with the cling wraping cellofen as a control of farmers' practice. Another group of geberllic acid treated fruits also kept without cling wraping. Then, the treated fruits were placed in the plastic foam packaging cup liner and kept in 25℃.

Fruit Firmness, TSS, Ascorbic Acid and Betacarotene

Fruit firmness was determined by using a Digital Firmness Tester. Total Soluble solids (TSS) content was measured by using a temperature-compensated automatic refractometer. Ascorbic acid content was determined according to Ranganna (2007). Total carotenoid extraction was done according Lee and Castle (2001) using Spectrophotometer.

Statistical analysis

One-way ANOVA analysis was performed with Statistical Analysis System – version 9.4 (SAS Institute, Cary, NC, USA) and where there was a significant difference between means, the Least Significance Difference (LSD) at $p = 0.05$ was calculated.

Results and Discussions

Guava is a very perishable fruit that loses its firmness during ripening, which is associated with its short postharvest life (Etemadipoor et al., 2019). Hydrolase and pectinase enzymes activity reduce the firmness of fruits, thereby causing the cell wall structure to degrade, besides the degradation of the primary cell wall and inter and intracellular materials (Hobson et al., 1987). The guava fruits treated with giberllic acid and wrapped in cling wrap cellofene resulted in the most firmness (120.20N and 102.48N) compared to the control (71.12N and 37.11N) and other treatments throughout the storage periods as shown in Tbale 1. GA in combination with cling wrap maintained the qualitative characteristics of guava fruit by reducing the ripening rate by acting as an excellent ethylene inhibitor (Ranjan *et al.*, 2005; Dhemre and Waskar, 2004). During storage, changes in firmness, TSS, ascorbic acid, and beta carotene (Table 2) decreased in treated fruits which might be due to an altered

atmosphere around the fruit and decrease in water loss. This altered atmosphere also can reduce the changes in pectin materials and the activity of cell wall degrading enzymes, which finally maintains the fruit firmness (Dong and Wang, 2018; Gurjar et al., 2018).

Conclusions

This study implies that gibberellic acid in combination with cling wrap has potential to extend the shelf life of guava. However, this is a first year trial and some more treatments will be added to the current treatments in the next year.

Table 1. Effect of giberllic acid and cling wraping on the flesh firmness of guava

Treatments	**Initial**	**Flesh Firmness (N)**	
		7 days	**14 days**
T_1 = Control		71.12d	37.11d
T_2 = Cling wrap		100.67bc	73.90bc
T_3 = 400 ppm GA	121.76	114.54ab	60.65cd
T_4 = 400 ppm GA+ Cling wrap		120.20a	102.48a
LSD[‡]		*16.3*	*28.5*

Values are the mean of 3 units of 15 fruits (1 batch x 3 replicates). [‡] Least significant difference between mean values in each column at $p = 0.05$.

Table 2. Effect of giberllic acid and cling wraping on the TSS, ascorbic acid and beta carotene of guava

Treatments	Storage periods of guava, days		
	Initial	7	14
		TSS (%)	
T_1 = Control		9.23a	9.10a
T_2 = Cling wrap		6.47d	7.63c
T_3 = 400 ppm GA	6.48	7.40b	8.97ab
T_4 = 400 ppm GA+ Cling wrap		7.33bc	7.10cd
LSD[‡]		*0.6*	*0.6*
		Vitamin C (mg/100g)	
T_1 = Control		252.00a	228.67d
T_2 = Cling wrap		243.00a	248.67bc
T_3 = 400 ppm GA	252	256.67a	258.67a
T_4 = 400 ppm GA+ Cling wrap		265.00a	251.00b
LSD[‡]		*26.0*	*7.0*
		Total carotenoid (µg/100g)	
T_1 = Control		38.34a	14.39d
T_2 = Cling wrap		29.93b	19.14c
T_3 = 400 ppm GA	37.90	20.20d	37.35a
T_4 = 400 ppm GA+ Cling wrap		27.95c	28.30b
LSD[‡]		*1.2*	*0.4*

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EFFECT OF POSTHARVEST TREATMENT AND EDIBLE WAX COATING ON IMPROVING QUALITY RETENTION AND SHELF LIFE OF BARI AAM-3

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Abstract

This experiment was conducted to study the effect of different postharvest treatments and fruit coatings that stimulate the fruit antioxidant system and will maintain postharvest quality of mango at ambient storage condition. BARI Aam-3 were dipped into hot water at 55°C for 5 mins and wax coating (Endura Fresh ™9000 & Endura Fresh ^{R}2400) was applied as a surface coating. Postharvest treatment was applied to control disease, reduce weight loss and increase shelf life for the study. Fruit immediately after hot water treatment using hand applicator on a washing & waxing line or left uncoated. Among the treatments, Endura Fresh ^{R}2400 with antimicrobial agent and carnauba wax (Endura Fresh ™9000) treated fruit performed best in terms of overall quality, and it significantly reduced weight loss (5.50-6.67%) after 12 days fruit harvested.

Introduction

Mango is a climacteric, with persistently high respiration and ethylene production rates during ripening and softening or compositional changes happen after harvest. It is king and popular fruit in Bangladesh. In 2022-2023 the total production of mango was about 1.48 million tons from 124 thousand hectares (BBS, 2023). Postharvest loss occurs after harvesting due to inappropriate postharvest management. Heat stress treatment has a significant role in controlling the quality of the produce. Slow down respiration and delay senescence are indispensable to maintain quality and shelf life (Escrinbano and Mitcham, 2014). Edible coating has the potential benefit of fruits to maintain properly internal atmosphere which stabilizes the produce and thereby promote shelf life. Coatings forms barrier against O_2 and CO_2 diffusion to reduce respiration rate.

Materials and Methods

BARI Aam-3 was collected from commercial farmers' orchard of Bagha, Rajshahi and then washed with 1000 ppm thiabendazole and 0.1% calcinated calcium and then treated with hot water at 55^{o}C for 5 mins. After that, food grade wax coating (Endura fresh ™9000 & Endura Fresh ^{R}2400) and another commercial postharvest treatment such as multi-fresh ethylene absorber and antimicrobial agent (Greenpod lab, India) were applied. Treated mango were washed appropriately by required amount of detergent conc. in the BARI fabricated brush pad @8-10 rpm for few seconds and then washed again with ambient water. For uniform surface coating a hand sprayer was used to apply wax @500 fruit/L on the fruit peel. The fruit surface was dried with hot air for 1-2 mins. Fruits were stored separately at ambient temperature. Weight loss (%PWL) was determined for 24-fruit per treatment compared to the initial weight just after treatment. The fruits were weighed every week for 3 weeks. Fruit firmness was determined by using a Digital Firmness Tester. Total Soluble solids (TSS) content was measured by using a temperature-compensated automatic refractometer. Ascorbic acid content was determined according to Ranganna (2007). Total carotenoid extraction was done according Lee and Castle (2001) using Spectrophotometer. The total antioxidant activity was determined based on the DPPH free radical scavenging activity and the method adopted by Kamal et al. (2019). Statistical analysis and data processing were performed using SPSS 17.0.

Results and Discussions

On Day-1, treatment T_4 (Endura Fresh ™9000 combined with an antimicrobial agent) exhibited the highest respiration rate (61.31 ml CO_2/kg-hr.), which was significantly higher ($p<0.05$) than all other treatments. In contrast, T_5 (Endura Fresh ^{R}2400 combined with an antimicrobial agent) demonstrated the lowest respiration rate (16.21 ml CO_2/kg-hr.), marking a significant difference ($p<0.05$) from the other treatments. However, by Day-12, there was a notable shift, T_5 displayed the highest respiration rate (282.83 ml CO_2/kg-hr.), significantly different from all other treatments, while T_3 (Endura Fresh ^{R}2400) exhibited the lowest respiration rate (158.43 ml CO_2/kg-hr.). In case of weight loss, T_1 (Control) exhibited the highest weight loss percentage (4.30%), which was significantly higher ($p<0.05$) than T_2, T_3 and T_5 at Day-1. Among the treated samples, T_2 (Endura fresh ™9000) and T_3 found the lowest weight loss percentages (2.11% & 1.85%, respectively), significantly lower than T_1 and T_4. On Day-12, T_1 again showed the highest weight loss percentage (13.20%), significantly

greater than all other treatments. T_2 demonstrated the lowest weight loss percentage (5.50%), significantly different from T_1 (Table 1).

The analysis of Total Soluble Solids (TSS) and ascorbic acid content across various treatments reveals distinct trends in fruit quality over time. Ascorbic acid content varied, with T_1 and T_3 showing recovery towards Day-12, contrasting with T_5 significant decline (Table 2). Titratable Acidity (TA) for all treatments, except for T_2 with its unusual value on Day-8, generally exhibited a decreasing trend in acidity over time. Antioxidant Activity for treatments T_3, T_4 and T_5 observed the highest levels of antioxidant activity, with T_3 significantly increasing over time (Table 3).

Conclusions

Mango treated with carnauba wax combined with antimicrobial agents was effective in reducing both respiration rate and weight loss, suggesting potential for extending the shelf life and maintaining quality.

Table 1. Effect of exogenous ethylene on Respiration rate and weight loss (%PWL) on treated mango during 3 weeks of storage

Treatment	Respiration (ml CO_2 /kg-hr.)				Weight loss (% PWL)		
	Initially	Day-4	Day-8	Day-12	Day-4	Day-8	Day-12
T_1	34.33±2.37c	214.94±1.68a	285.42±3.35a	-	4.30±0.07a	8.89±0.8a	13.20±0.33a
T_2	46.24±2.28b	184.28±1.386ab	240.27±6.43ab	179.55±1.04b	2.11±0.52b	4.06±0.50c	5.50±0.82b
T_3	47.59±5.02b	170.12±1.52b	238.01±1.75ab	158.43±4.31c	1.85±0.18b	4.19±0.38c	6.02±0.8b
T_4	61.31±0.93a	149.58±1.86bc	195.19±1.78b	177.2±3.01b	3.95±1.22a	5.96±1.03b	6.81±0.03b
T_5	16.21±2.46d	127.51±0.97c	104.91±1.51c	282.83±3.01a	2.28±0.16b	4.67±0.46bc	6.67±0.41b

Values are mean ± standard deviation of 3 replicates; Different lowercase letters in each column are differed significantly among the samples. Note: T_1=Control; T_2= Carnauba wax 9000; T_3= Endura Fresh ^{R}2400; T_4= Carnauba 9000+Antimicrobial treatment; and T_5= Endura Fresh ^{R}2400+ Antimicrobial treatment.

Table 2. Effect of total soluble solids (%) and ascorbic acid (mg/100g) on treated mango during 3 weeks of storage

Treatment	Total soluble solids (%)			Ascorbic acid (mg/100g)		
	Day-4	Day-8	Day-12	Day-4	Day-8	Day-12
T_1	20.13±1.05a	22.60±0.30bc	18.66±0.61	29.00±1.00a	23.67±1.53a	26.00±1.00bb
T_2	19.56±0.81a	25.15±0.15a	15.97±0.75a	24.67±0.57b	24.33±0.57a	24.00±1.00bc
T_3	17.87±3.19a	21.43±0.55c	14.17±0.35	21.00±1.00c	20.66±3.05a	28.67±0.57a
T_4	19.90±0.45a	21.67±0.65b	13.36±0.35b	25.00±1.00b	22.00±1.00a	22.00±1.00c
T_5	17.5±0.26a	21.33±1.21c	16.83±0.20b	28.00±1.00a	20.33±1.52a	18.00±1.00d

Values are mean ± standard deviation of 3 replicates; Different lowercase letters in each column are differed significantly among the samples. Note: T_1=Control; T_2= Carnauba wax 9000; T_3= Endura Fresh ^{R}2400; T_4= Carnauba 9000+Antimicrobial treatment; and T_5= Endura Fresh ^{R}2400+ Antimicrobial treatment.

Table 3. Effect of Titratable Acid (%) and antioxidant (% inhibition) on treated mango during 3 weeks of storage

Treatment	Titratable Acid (%)			Antioxidant (% inhibition)		
	Day-4	Day-8	Day-12	Day-4	Day-8	Day-12
T_1	0.11±0.01b	0.12±0.03b	0.08±0.02b	48.09±0.73b	48.33±0.58c	47.44±0.45d
T_2	0.14±0.01ab	19.00±0.01a	0.06±0.02b	44.71±0.69c	43.26±0.29d	44.28±0.28e
T_3	0.17±0.02a	0.16±0.02ab	0.12±0.00a	43.24±0.46b	62.99±0.79a	63.83±0.89a
T_4	0.13±0.02b	0.13±0.01b	0.08±0.02b	60.92±0.87c	58.46±0.81b	62.04±0.38b
T_5	0.13±0.02ab	0.14±0.02ab	0.08±0.02b	69.92±0.87a	65.22±3.06a	54.09±0.61c

Values are mean ± standard deviation of 3 replicates; Different lowercase letters in each column are differed significantly among the samples. Note: T_1=Control; T_2= Carnauba wax 9000; T_3= Endura Fresh ^{R}2400; T_4= Carnauba 9000+Antimicrobial treatment; and T_5= Endura Fresh ^{R}2400+ Antimicrobial treatment.

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STANDARDIZATION OF DOSES OF ETHYLENE GAS FOR UNIFORM RIPENING OF TOMATO IN LOW-COST RIPENING CHAMBER

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Abstract

The experiment was conducted to standardize the doses of ethylene for uniform ripening of tomato (*Solanum lycopersicum* L.) in low-cost ripening chamber. Udayan variety tomato at breaker stage was harvested at HRC field of BARI and treated with 0, 50, 100, 150 and 200 ppm concentration of exogenous ethylene gas at BARI developed low-cost ripening chamber at PHTD, Gazipur where temperature maintained at 20±2 ^{o}C and 80±5% RH. Among the treatment, tomato treated with 100 ppm performed better quality and observed optimum ripening after 4 days of storage at ambient condition (26±2^{o}C and 75±5% RH). After 8 days of storage, the optimum firmness was (6.97 N) observed in 100 ppm treated tomato.

Introduction

Tomatoes (*Solanum lycopersicum* L.*)* are popular fruit vegetables for higher nutritional profile and health benefits. They are filled with vitamins, minerals, fiber, and bioactive compounds, which contribute to various physiological functions and the prevention of chronic diseases. Among these, lycopene and carotenoids are crucial for maintaining health (Sattar *et al.,* 2024)**.** Ethylene is a plant hormone that plays a crucial role in the ripening process of tomatoes, influencing their nutritional quality. Increased ethylene levels can enhance the concentration of carotenoids linked to numerous health benefits, such as reducing the risk of certain cancers and promoting heart health. Ethylene also affects the flavor profile of tomatoes by influencing the production of sugars and organic acids, which contribute to their taste and overall nutritional value. The ripening process, driven by ethylene, leads to changes in the nutritional composition, making ripe tomatoes more beneficial for health compared to unripe ones. Additionally, ethylene can impact the texture and shelf life of tomatoes, which indirectly affects their nutritional retention during storage and processing. Optimum ripening using appropriate ethylene gas concentration is required for matured tomatoes. Overall, role of ethylene gas for tomato ripening is vital for enhancing their nutritional components, making them a more valuable food source.

Materials and Methods

Udayan varieties of tomatoes turned to breaker stage were collected from HRC field of BARI, Gazipur. The fruits were washed and then exposed to different ethylene gas concentrations such as 0, 50, 100, 150 and 200 ppm for overnight in a fruit ripening chamber of PHTD, BARI. After that, the fruits were kept at 20±2°C with 80±5%RH and at ambient temperature for 12 days. Each treatment was replicated three times. Physical appearance and nutritional quality with shelf life were evaluated. Textural properties of fried pineapple chips were determined to estimate resistance by a texture analyzer (Stable Micro System, Godalming, UK). The analyzer prove (p-5) was directly inserted in the middle of the chips by the back extrusion method. Total carotenoid extraction was done according Lee and Castle (2001) using Spectrophotometer. The experiment was laid-out in "Completely Randomized Design" and analyzed using SPSS 17.0.

Results and Discussions

The application of exogenous ethylene significantly influences the ripening process of tomatoes, as shown by the respiration rate and ethylene rate data presented in Figure 1. This figure illustrates a clear dose-dependent relationship between ethylene concentration and respiration rates over a 12-day period, highlighting ethylene's critical role in climacteric fruit ripening. Tomato treated with 50 ppm C_2H_4, respiration increased from 20.64 ml CO_2 /kg-hr. on Day-1 to 44.59 ml CO_2 /kg-hr. by Day-4, indicating accelerated ripening. Higher concentrations, such as 100 ppm, showed a rise from 24.85-61.15 ml CO_2 /kg-hr., while 200 ppm peaked at 68.86 ml CO_2 /kg-hr., demonstrating a more pronounced effect. The stabilization of respiration rates from Day-4 suggests a saturation point in the ripening process, where ethylene receptors may be fully activated. The findings align with the understanding that ethylene triggers physiological changes, including increased respiration, color change, and softening, essential for ripening (Gambhir *et al.,* 2023). While the data strongly supports the role of ethylene in accelerating ripening, it is essential to consider that excessive ethylene may lead to over-ripening or quality degradation, necessitating careful management in postharvest practices. Besides,

Weight loss was lowest at Day-8 in T_5 (200 ppm) but it is similar for T_3 (100 ppm) treatment. Firmness and carotene were better in T_3 treated tomatoes (Table 1). Overall, T_3 (100 ppm) was the optimum doses of ethylene gas for uniform ripening of tomatoes.

Conclusion

Optimum ripening of tomato achieved after 4 days of ripening at 20°C through exogenous ethylene gas concentration at 100 ppm. The optimum firmness was (6.97 N) observed in 100 ppm treated tomato after 8 days of storage.

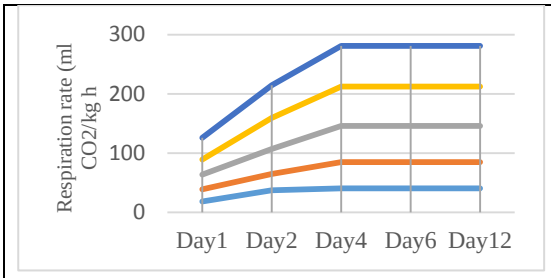

Figure 1(a). Changes of respiration rate of tomatoes during 12 days of storage

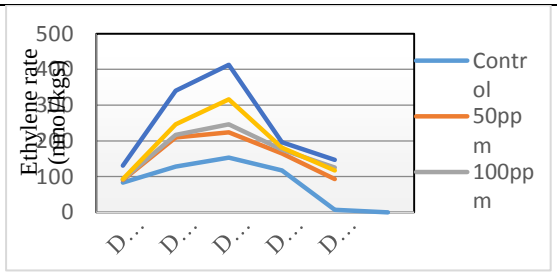

Figure 1(b). Changes of ethylene rate of tomatoes during 12 days of storage

Table1. Changes of weight loss, firmness (N) and carotenoids of tomatoes (var. 'Udayan') on the application of different ethylene gas concentration during 8 days of storage

Treatment	Storage (Day)	Weight loss (% PWL)	Firmness (N)	Total carotenoids (mg/100g)
T_1	2	-	17.58± 3.04a	-
	4	3.086±0.37a	17.79±0.86a	34.40±2.25c
	6	5.76±0.42a	14.63±0.39a	9.00±1.54b
	8	8.48±0.33a	9.28±0.20a	-
T_2	2	-	8.74±0.49b	
	4	3.29±0.20a	8.033±1.52b	46.97±3.14b
	6	4.11±2.76ab	7.45±0.13b	48.37±0.64a
	8	6.73±2.74ab	6.97±0.37b	8.32±0.09b
T_3	2	-	9.76±1.12b	-
	4	1.53±0.48b	9.46±0.76b	53.13±2.78a
	6	2.66±0.51ab	8.52±1.27b	48.79±0.29a
	8	5.97±1.12ab	8.47±1.03ab	12.66±3.50a
T4	2	-	11.09±0.10b	
	4	1.51±0.07b	10.47±1.27b	54.89±0.32a
	6	2.13±0.11b	8.54±0.85b	47.58±0.65a
	8	4.35±0.52b	7.58±0.35ab	10.49±0.73ab
T5	2	-	11.79±0.34b	-
	4	1.18±0.21b	9.52±0.77b	54.62±0.44a
	6	1.83±0.25b	9.08±1.73b	46.56±1.88a
	8	4.27±0.53b	8.73±0.79a	12.34±0.86a

Values are mean ± standard deviation of 3 replicates; Different lowercase letters in each column are differed significantly among the samples. Note: T_1= 0 ppm (Control); T_2 = 50 ppm; T_3 = 100 ppm; T_4 = 150 ppm; and T_5 = 200 ppm

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STANDARDIZATION OF DOSES OF ETHYLENE GAS FOR UNIFORM RIPENING AND POSTHARVEST QUALITY OF BANANA DURING STORAGE

M.G.F. CHOWDHURY, M.H.H. KHAN, M.M.RAHMAN, R.ISLAM

Abstract

The experiment was conducted to evaluate the effect of ethylene for standardization of doses exogenous ethylene gas concentration for uniform ripening of banana (*Musa spp.*) in low-cost ripening chamber at PHTD, BARI. Uniform with physiologically matured green banana (BARI kola-1) were collected from farmers' orchard in Gazipur and treated with 0, 50, 100 and 150 ppm concentration of ethylene gas at BARI developed low-cost ripening chamber where temperature maintained at 20±2^{o}C & 80±5% RH. Among the treatment, banana treated with 100 ppm performed better quality and noted optimum ripening at ambient condition (26±2^{o}C & 75±5% RH) where the titrable acid (1.16%) and ascorbic acid (2.11 mg/100g) were exhibited almost minimum after 8 days of storage.

Introduction

Bananas *(Musa spp.)* are vital for nutrition and economy in developing countries. Bananas are fleshy simple fruits with a soft epicarp and a very fleshy, edible mesocarp and endocarp comprised of starchy parenchyma Ripening of this climacteric fruits is regulated by ethylene and it consist of a series of biochemical and physiological changes, including fruit color, texture, aroma and flavor. It depends on the presence or absence of rise in respiration and ethylene production. During ripening, the crisp, hard, and dark green banana is transformed into a yellow fruit with tender and soft internal pulp at the full ripening stage. A few days after the fruit ripens, it is inedible due to over-ripening. The spoilage includes excessive softening and changes in taste, aroma, and skin color (Ramírez-Sánchez *et al.*, 2018). They exhibit significant changes in ethylene production and respiration rates during ripening, making them prone to rapid deterioration and substantial losses during storage and handling (Bi et *al.*, 2017).

Materials and Methods

Green bananas *(Musa spp.)* were collected and 0, 50, 100 and 150 ppm of exogenous ethylene gas were applied for overnight at 20±2°C & 80±5% RH at Postharvest Technology Divisional Low-cost Ripening Chamber (L=3.5m×2m×2m). Three replications of selected clusters were taken at initially, 2, 4, 6 and 8 days for physicochemical analysis. Six banana fingers were randomly selected and separated from the clusters at each ripening/storage interval. Two banana fingers per replicate were sealed in 1.4-L container for determination of respiration and ethylene through Quantek Instruments and CID Gas Analyzer respectively. Total soluble solids concentration (TSS), total acidity content (TA) and ascorbic acid content with other nutritional attributes were investigated during the study.

Results and Discussions

The respiration rate in the control treatment shows a gradual increase from initially (Day-1) (20.18 ml CO_2/kg·hr.) to Day-6 (136.09 ml CO_2/kg·hr.). This treatment consistently states the lowest respiration rates across all days during the study. The respiration rate in T_2 (50 ppm C_2H_4) shows a significant increase from Day-1 (29.40 ml CO_2/kg·hr.) to Day-2 (106.67 ml CO_2/kg·hr.). After this, the rate increases marginally until Day 6 (134.29 ml CO_2/kg·hr.), indicating a strong initial response followed by stabilization. Treatment T_3 (100 ppm C_2H_4) exhibits a consistent rise in respiration rate from Day-1 (63.98 ml CO_2/kg·hr.) to Day-6 (184.07 ml CO_2/kg·hr.), with significantly higher rates than T_1 (0 ppm C_2H_4) and T_2 (50 ppm C_2H_4). This suggests a dose-dependent increase in respiration rate with higher concentrations of C_2H_4 gas. Ethylene production in the control treatment (0 ppm) steadily increases from Day-1 (92.73 nmol/kg·s) to Day-4 (323.52 nmol/kg·s), followed by a decrease on Day-6 (120.82 nmol/kg·s). This is the lowest ethylene production across all treatments. Ethylene production exhibits initially high in treatment T_3 (100 ppm C_2H_4) and increases until Day-2 (442.22 nmol/kg·s), then decreases slightly by Day-4 (325.84 nmol/kg·s) and continues to decrease on Day-6 (189.22 nmol/kg·s). This indicates a high initial response that tapers off over time.

In Table 2, T_1 (0 ppm C_2H_4, Control) exhibits the highest PWL on both Day-4 (3.11%) and Day-8 (5.77%), indicating significant weight loss in the absence of ethylene treatment. In contrast, treatment T_4 (150 ppm) demonstrates the lowest PWL on Day-4 (1.48%) and Day-8 (2.16%), suggesting that higher concentrations of ethylene effectively reduce weight loss, possibly by minimizing respiration rates and water loss. TSS content increases in all treatments over time,

indicative of the ripening process where starch is converted into sugars. Treatment T_4 (150 ppm C_2H_4) consistently shows the highest TSS values (25.07 ^oB on Day-4 and 28.80 ^oB on Day-8), indicating a more advanced ripening process.

The titratable acidity decreases across all treatments over time, which aligns with the typical reduction of organic acids during fruit ripening. Treatment T_1 (Control) maintains a high and constant acidity level (2.36% on both Day-4 and Day-8), suggesting a delay in acid degradation.

Ascorbic acid levels decline for all treatments during storage, reflecting the natural degradation of vitamin C as the fruit ripens. T_1 (Control) maintains the highest levels (5.50 mg/100g on Day-4 and 4.76 mg/100g on Day-8), while T_4 (150 ppm) shows a substantial reduction (3.00 mg/100g to 2.11 mg/100g). This suggests that ethylene treatments, especially at higher concentrations, accelerate the ripening process, which in turn accelerates the degradation of ascorbic acid.

Table1. Changes of respiration of exogenous C_2H_4 treated with Banana fruit during ambient storage

Treatment	Respiration (ml CO_2 /Kg.hr)				Ethylene (nmol/kg.s)			
	Day 1	Day 2	Day 4	Day 6	Day 1	Day 2	Day 4	Day 6
T_1	20.18±0.67c	26.19±0.26d	42.19±0.26c	136.09±1.48c	92.73±4.54c	115.37±2.11c	323.52±0.67b	120.82±1.64c
T_2	29.40±0.77b	106.67±1.7c	114.52±0.240b	134.29±2.48c	210.10±0.79b	430.22±1.72b	331.32±7.19b	164.81±3.39b
T_3	63.98±6.84a	137.32±2.39b	143.30±2.41a	184.067±5.72a	213.87±0.41b	442.22±8.44b	325.84±4.22b	189.22±0.99a
T_4	66.65±0.74a	146.09±2.56a	146.68±3.04a	172.28±2.60b	265.92±2.25a	539.04±3.75a	409.39±4.08a	191.23±9.29a

Values are Mean ± SD (n=3); Means followed by different lowercase letters in each differed significantly ($P<0.05$) among the treatments. Note: T_1=Control; T_2=50ppm; T_3=100ppm; T_4=150ppm.

Table 2. Physiological and biochemical changes of exogenous C_2H_4 treated with Banana fruit during ambient storage

Treatment	Storage (Day)	PWL (%)	TSS (^{o}Brix)	Titratable acid (%)	Ascorbic acid (mg/100g)
T_1	4	3.11±0.02a	11.13±0.15d	2.36±0.28a	5.50±0.26a
	8	5.77±0.09a	12.63±0.15d	2.36±0.02a	4.76±0.05a
T_2	4	2.91±0.05b	20.13±0.55c	1.26±0.021b	4.58±0.26b
	8	5.49±0.18a	24.43±0.05c	1.03±0.01b	2.20±0.34b
T_3	4	1.55±0.02c	22.63±0.15b	1.44±0.03b	4.43±0.08b
	8	2.69±0.06b	25.77±0.63b	1.16±0.02b	2.11±0.01b
T_4	4	1.48±0.03c	25.07±0.06a	1.57±0.49b	3.00±0.20c
	8	2.16±0.06c	28.80±0.10a	1.17±0.03b	2.11±0.01b

Values are mean ± standard deviation of 3 replicates; Different lowercase letters in each column are differed significantly among the samples. Note: T_1 = 0 ppm, Control; T_2 = 50 ppm; T_3 = 100 ppm and T_4 = 150ppm; PWL = Physiological wt. loss

Conclusion

The results indicate that exogenous ethylene treatments, particularly at higher concentrations of C_2H_4 gas (100-150 ppm), significantly enhance the ripening process in bananas by increasing TSS and reducing weight loss. However, this accelerated ripening comes at the cost of faster degradation of titratable acidity and ascorbic acid. Depending on the desired shelf life and quality attributes, different concentrations of ethylene could be used to optimize the ripening and storage of bananas.

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STANDARDIZATION OF DOSES OF ETHYLENE GAS FOR UNIFORM RIPENING AND POSTHARVEST QUALITY OF MANGO DURING STORAGE

M.G.F. CHOWDHURY, M.H.H. KHAN, M.M.RAHMAN, R.ISLAM

Abstract

The experiment was conducted to standardize the doses of exogenous ethylene gas for uniform ripening of mango (*Mangifera indica* L.) in BARI developed Low-Cost Ripening Chamber. Uniform with physiologically matured mango (BARI Aam-2) were collected from a commercial farmer's orchard of Bagha, Rajshahi and treated with 0, 50, 100 and 150 ppm of exogenous ethylene gas at PHTD, BARI where temperature maintained at 20±2 ^{o}C with 80±5% RH. Among the treatment, mango treated with 100 ppm performed better quality and noted optimum ripening at ambient condition (26±2^{o}C & 75±5% RH).

Introduction

Mango (*Mangifera indica L.*) is a tropical fruit known for its unique flavor, aroma, and nutritional value. As a climacteric fruit, mango undergoes significant physiological and biochemical changes during ripening, which are primarily regulated by ethylene, a plant hormone. Exogenous application of ethylene is commonly used in post-harvest management to control and accelerate the ripening process, ensuring uniform ripening, improved color development, enhanced flavor with nutritional quality. This report examines the effects of different concentrations of exogenous ethylene on the uniform ripening of mangoes (BARI Aam-2), focusing on key parameters such as respiration rate, physiological weight loss (PWL) and quality attributes such as total soluble solids (TSS), titratable acidity (TA), and Vitamin A content.

Materials and Methods

Physiologically matured mangoes (BARI Aam-2) were collected from a commercial farmers orchard of Bagha, Rajshahi and 0, 50, 100 and 150 ppm of exogenous ethylene gas were applied through an ethylene generator for overnight at 20±2°C and 75±5%RH at the Postharvest Technology Divisional Low-cost Ripening Chamber of PHTD, BARI (L=3.5m×2m×2m). Three replications of selected clusters were taken at initially and 2 days interval up to 8 days for respiration rate 4 days interval up to 12 days for physicochemical analysis. The study involved treating mature green mangoes with different concentrations of exogenous ethylene gas application to evaluate ripening responses and shelf life. Mangoes were stored at ambient temperature (26±2°C and 75±5%RH) and nutritional composition were recorded initially and 4 days interval up to 12 days. Key parameters such as physiological weight loss (%PWL), total soluble solids (TSS, ^{o}Brix), titratable acidity (TA, %) and Vitamin A content (mg/100g) were evaluated (Ranganna, 2007).

Results and Discussions

Respiration rates in response to varying ethylene concentrations reveals significant metabolic responses influenced by treatment levels over time. Initially (On Day-1), T_3 (100 ppm) and T_4 (150 ppm) exhibited the highest respiration rates (39.93±3.93 CO_2/kg.hr. and 39.95±0.52 ml CO_2/kg.hr., respectively), significantly surpassing control and lower concentrations. On Day-6, treatment T_4 (150 ppm) declined to 56.20±2.28 ml CO_2/kg.hr., signifying potential metabolic adjustments at high concentrations (Table 1).

Physiological weight loss (PWL) increased over time for all treatments (Table 2). The control treatment (0 ppm) exhibited the highest PWL by Day-12 (11.78%), indicating substantial moisture loss. In contrast, T_2 (50 ppm), T_3 (100 ppm), and T_4 (150 ppm) exhibited lower PWL initially, suggesting that ethylene treatments assist to reduce moisture loss by modulating transpiration rates. However, by Day-12, T_3 (100 ppm), and T_4 (150 ppm) recorded increased PWL (6.35% & 6.50%, respectively), reflecting accelerated metabolic activity.

Total soluble solids (TSS) which measures sugar content and ripeness, increased in all treatments over time (Table 2). The highest TSS levels were observed in T_3 (100 ppm) and T_4 (150 ppm) by Day-12 (18.16 ^{o}B & 18.17 ^{o}B, respectively), indicating enhanced carbohydrate metabolism due to ethylene. In case of titratable acidity (TA), treatment T_2 (50 ppm) maintained higher acidity levels until Day-8 (0.20%) but observed a decline trend by Day-12 (0.05%). Similarly, vitamin A content, a critical nutritional parameter, was significantly influenced by ethylene application. T_3 (100 ppm) exhibited the highest Vitamin A levels by Day-12 (19.34 mg/100g), indicating that this

concentration helps maintain or enhance nutrient content. T_4 (150 ppm) maintained maximum vitamin A levels up to Day-8.

Conclusion

The findings highlight that 100 ppm C_2H_4 treated mangoes may provide an optimal balance, enhancing sweetness and preserving nutrients while minimizing weight loss, making it suitable for managing postharvest quality. This application led to 100% ripening for 12 hours in approximately four days compared to control mangoes.

Table 1. Changes of respiration (ml CO_2 /Kg.hr.) of C_2H_4 treated Mangoes at ambient storage

Treatment (ppm, C_2H_4)	Initially	Day-2	Day-4	Day-6	Day-8
T_1	26.61±3.72c	39.22±0.27c	48.31±3.76c	65.17±1.92b	32.28±1.83c
T_2	34.9±0.05b	63.62±0.61b	75.88±1.94b	54.13±2.48c	17.54±2.2b
T_3	39.93±3.93a	68.64±2.64b	81.17±2.41a	76.71±2.21a	18.49±1.86b
T_4	39.95±0.52a	80.67±4.68a	81.98±3.04a	56.20±2.280c	41.59±0.23a

Values are Mean ± SD (n=3); Means followed by different lowercase letters in each differed significantly ($P<0.05$) among the treatments. Note: T_1=Control; T_2=50ppm; T_3=100ppm; T_4=150ppm.

Table 2. Physiochemical changes of C_2H_4 treated Mangoes at ambient storage

Treatment (ppm, C_2H_4)	Storage (Day)	PWL (%)	TSS (^{o}Brix)	Titratable acid (%)	Vitamin A (mg/100g)
T_1	4	4.11±0.02a	13.23±0.25d	0.11±0.01c	9.59±0.32c
	8	7.73±0.15a	15.40±0.10	0.12±0.02b	10.29±0.27d
	12	11.78±0.28a	16.4±0.10	0.08±0.00ab	12.71±0.15
T_2	4	1.69±0.02b	14.23±0.25c	0.15±0.01b	11.77±0.26b
	8	3.77±0.02a	15.70±0.10	0.20±0.01a	13.75±0.04c
	12	4.2±0.17c	17.33±0.28	0.05±0.01c	8.51±0.38a
T_3	4	1.08±0.01d	16.86±0.15a	0.17±0.05a	12.35±0.34b
	8	3.65±0.04b	16.93±0.15	0.16±0.02ab	16.62±0.10b
	12	6.35±0.53b	18.16±1.27	0.11±0.00a	19.34±0.11b
T_4	4	1.55±0.03c	14.97±0.25b	0.12±0.01c	13.26±0.17a
	8	3.15±0.04c	16.50±2.43	0.13±0.02b	18.04±0.22a
	12	6.50±0.25b	18.17±1.55	0.08±0.02ab	9.03±0.02bc

Values are mean ± standard deviation of 3 replicates; Different lowercase letters in each column are differed significantly among the samples. Note: T_1=Control; T_2=50ppm; T_3=100ppm and T_4=150ppm

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EFFECT OF MALTODEXTRIN AND SODIUM CHLORIDE ON THE QUALITY ATTRIBUTES AND STORAGE LIFE OF VACUUM FRIED MANGO CHIPS

M.G.F. CHOWDHURY, M.H.H. KHAN, M.M. MOLLA, P.SEN, R.ISLAM

Abstract

The aim of the study was to evaluate vacuum fried mango chips processing using BARI developed vacuum fryer at suitable frying temperature and time. Early harvested green mango (unknown commercial) were collected from Gazipur and peeled and then thinly sliced (2-3 mm). Six treatments such as 20% maltrodextrin (MD), 20% MD with 10% NaCl, 20% MD with 10% NaCl and freezing (-14^{o}C), 20% MD and direct frying, preserved 10% salted mango (>6 months storage) and without any treatment were examined. Raw mango slices were vacuum fried at 105^{o}C for 30 mins was used for frying and then were de-oiled at 1400 rpm for 2-3 mins. Final products were packed in metalex foil packet (3 layer, ~60 micron) and nutritional quality with storage life was observed for 3 months. Among the treatments, 20% MD with 10% salt and then freezing performed better in terms of nutritional quality and 3 months of ambient storage (26±2^{o}C & 75±5% RH).

Introduction

Mango is one of the major and popular fruit in Bangladesh and widely cultivated. The annual production is about 148.23 thousand MT covering an area of 123.92 thousand hectares during 2022-2023 (BBS, 2023). It is mainly eaten as fresh with ripe form and a little percent is used as processed products. Mango loss in Bangladesh is a significant concern, with current estimates indicating a total postharvest loss rate of approximately 30.65%. This loss occurs due to inadequate handling practices and technology (Sarker *et al.,* 2023). Vacuum frying is an emerging and novel technology for preparing chips. Due to lower frying temperature vacuum fryer makes the products healthier as they taste better and crispier and contain minimum residual oil and retain more nutrients.

Materials and Methods

Unknown commercial and early harvested green mango (not fully matured) was collected from Gazipur Chowrasta Bazar and then transported to PHTD, BARI. Mangoes were peeled with thinly sliced (2-3 mm) and then added 20% MD, 20% MD with 10% NaCl, 20% MD with 10% NaCl and freezing (-14^{o}C), 20% MD and direct frying and preserved 10% salted mango. Without any treatment was considered as control. Raw chips were packed in a HDPE packet (~60 micron) and stored in a refrigerator (-14^{o}C) for 12-24 hrs. After 2-3 mins de-oiled, metalex foil packet was used for evaluating nutritional quality and storage life during 3 months of storage at one month interval. Moisture content was determined according to the method described by AOAC method (AOAC, 2005). Textural properties of chips were determined to estimate resistance by a texture analyzer (Stable Micro System, Godalming, UK). The analyzer proves (p-5) was directly inserted in the middle of the chips by the back extrusion method. The titratable acidity and ascorbic acid were determined following the methods of Ranganna (2007). The total antioxidant activity of vacuum fried chips was determined based on the DPPH free radical scavenging activity and expressed as the percentage inhibition. Statistical analysis and data processing were performed using SPSS 17.0.

Results and Discussions

In Table 1, moisture content increased slightly over the storage periods for all treatments. T_1 exhibits an increase from 3.94% initially to 7.84% after 3 months of storage, while T_2 presents a significant increase from 1.038% initially to 3.65% after 2 months and then decreases to 3.16% after 3 months of storage. T_6 (preserved mango) maintains a higher moisture content from 1st month to 3rd month compared to other treated samples (Table 1). In case titratable acidity (TA) values treatment T_2 and T_3, remain relatively stable, with slight fluctuations over time. Treatment T_4 found a significant increase in titratable acidity from 2nd month to 3rd month potentially due to microbial activity or chemical changes during storage. Treatment T_5 (20% MD with direct frying) exhibits the highest TA at 1st month (5.31%) but decreases significantly by 2nd month (3.03%). Similarly, ascorbic acid content varies significantly among the treatments. Treatment T_1 (control) observes high initial values (69.07 mg/100g), while treatment T_6 (preserved salted mango) starts with the lowest value (21.47 mg/100g). The use of certain preservatives (as in T_2, T_3 & T_6) appears to help retain some antioxidant properties (Table 1). Treatment T_5 tends to retain more energy over time compared to other treatments. This treatment has the energy value 919±0.07, 897±2.42, 631±0.98, 730±0.08 kcal/100g from initially to 3rd month of storage, respectively. Treatment, T_4 includes both freezing and salted

mango, exhibits significant energy losses initially but stabilizes somewhat after 2 months where the energy value range from 951 to 709 kcal/100g (Table 2).

Conclusion

Maltodextrin, either alone or combined treatments effectively maintained titratable acidity, ascorbic acid, and firmness during 3 months storage. Overall, 20% MD, 10% NaCl and freezing performs better considering nutritional attributes of mango chips using vacuum fryer. The experiment is in progress.

Table 1. Physicochemical properties of VF Mango Chips during 3 months of storage at ambient condition

Treatments	Storage (month)	Moisture (%)	Titratable acid (%)	Ascorbic acid (mg/100g)	Antioxidant (% inhibition)	Texture (N)
T_1	Initial	3.94±0.59a	4.53±0.16b	69.07±1.01bc	66.58±0.53a	82.41±1.67a
	1	5.70±1.13a	4.68±0.02b	64.83±0.15c	66.63±0.55a	71.97±1.55a
	2	5.03±1.07a	3.37±0.03c	72.00±1.00b	61.54±1.26a	79.71±3.15b
	3	7.84±0.67a	3.33±0.13a	70.00±1.00a	58.77±1.16a	153.03±7.27a
T_2	Initial	1.038±0.08b	4.98±0.083b	62±5.29c	61.16±1.82a	70.81±15.93a
	1	2.01±0.049ab	5.098±0.027a	62.27±0.25c	62.85±0.83a	71.57±11.90a
	2	3.65±0.64ab	4.39±0.02b	62.67±1.53c	60.98±1.07a	107.59±0.39a
	3	3.16±0.28b	3.33±0.13a	51.00±1.00b	58.50±1.89a	96.91±4.37b
T_3	Initial	1.70±0.98b	3.84±0.16c	75.10±2.65a	55.24±1.83b	36.86±0.60b
	1	1.65±0.11b	4.07±0.03b	74±0.21a	57.36±1.03b	37.64±1.09b
	2	2.85±0.76b	3.97±0.03c	38.70±1.53d	52.36±1.27b	10.10±0.39d
	3	2.84±0.42b	3.45±0.13a	36.00±1.00d	50.20±0.85b	10.26±15.73d
T_4	Initial	0.78±0.45c	4.22±0.21b	71.93±0.40b	64.59±1.39a	23.15±1.21c
	1	1.64±0.12b	4.54±0.03b	71.13±0.25b	67.70±1.49a	26.76±2.26c
	2	2.75±0.1b	5.10±0.02a	67.33±2.08c	58.85±1.24b	26.51±3.52c
	3	2.21±0.54b	3.41±0.08a	48.67±0.58	56.42±0.80a	94.82±2.97b
T_5	Initial	1.43±0.60b	5.04±0.2a	76.17±2.83a	51.49±0.49b	31.09±0.84b
	1	1.91±0.58b	5.31±0.00a	78.73±0.21a	51.55±0.70c	68.86±3.60a
	2	2.5±0.43b	3.03±0.00c	77.67±1.53a	48.60±0.87c	77.12±3.24b
	3	2.87±0.17	3.97±0.3a	59.33±2.52c	45.69±0.49c	94.22±7.1b
T_6	Initial	1.8±0.68b	1.44±0.13d	21.47±0.25d	46.65±1.94d	21.01±0.844d
	1	2.7±0.42ab	2.85±0.03c	22.33±2.08d	48.42±0.78d	21.51±2.48d
	2	3.28±0.39b	2.03±0.03c	12.00±2.00d	46.21±1.33c	11.11±1.98d
	3	3.67±0.39c	2.17±0.13b	12.83±0.15d	43.21±0.57c	19.29±0.76c

Values are mean ± standard deviation of 3 replicates; Different lowercase letters in each column are differed significantly among the samples. Note: MD=Maltodextrin; T_1=Control; T_2=20%MD; and T_3=20% MD+10% NaCl; T_4=20%MD+10% NaCl+freezing; T_5=20%MD+ direct frying; T_6= Preserved 10% salted mango (>6 months), VF=Vacuum frying

Table 2. Energy value (Kcal/100g) of VF Mango chips during 3 months of storage at ambient condition

Treatments	0 Month (Initial)	1-Month	2-Month	3-Month
T_1	916±0.21b	803±0.41c	633±3.12b	678±0.13b
T_2	942±4.24ab	852±0.87ab	791±2.42a	693±0.08b
T_3	934±0.55b	879±0.63a	614±3.05b	623±0.03b
T_4	951±0.77a	798±4.22c	602±0.43b	709±0.07a
T_5	919±0.07b	897±2.42a	631±0.98b	730±0.08a

Values are mean ± standard deviation of 3 replicates; Different lowercase letters in each column are differed significantly among the samples. Note: MD=Maltodextrin; T_1=Control; T_2=20%MD; and T_3=20% MD+10% NaCl; T_4=20%MD+10% NaCl+freezing; T_5=20%MD+ direct frying; T_6= Preserved 10% salted mango (>6 months); VF=Vacuum frying

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EFFECT OF MALTODEXTRIN ON NUTRITIONAL AND BIOACTIVE COMPOUNDS OF FREEZE-DRIED MANGO CHIPS

M.G.F. CHOWDHURY, M.H.H. KHAN, S. PERVIN, R.ISLAM

Abstract

The aim of the study was to standardize the freeze-dried mango chips processing protocol by application of maltodextrin (MD) as food additives for cell integration. Mango chips were prepared from matured semi-ripe mango. The harvested mango (Fazli) was collected from a commercial mango orchard of Bagha, Rajshahi to PHTD, BARI. Then mangoes were washed and cut into slices about 3-5 mm thickness and treated with different concentration such as 1.5%, 3%, 4.5% & 6% of MD then kept in high density polyethylene packet (HDPE) (~60 micron) and frozen at -18ºC for 24-36 hrs. The frozen slices were dried in freeze dryer at -55^{o}C for 48-72 hrs. and the dried mango chips were packaged in foil (~50 micron) packet without nitrogen flashing. According to the quality attributes, 6% MD coated mango chips performed better processing protocol in terms of physical appearance and nutritional quality.

Introduction

Mango is a climacteric fruit which is normally harvested at green mature stage. Due to the highly perishable nature of the mango fruit, significant amount of quantitative and qualitative postharvest losses occurs during marketing (Ntsoane *et al.,* 2019). Value addition is an important alternative for reducing the postharvest losses of this nutritive fruit. Freeze drying is applicable to preparing biological products that are unstable in aqueous solutions for prolonged storage periods, but that are stable in the dry form. Keeping this in view, the program was conducted to develop the freeze-dried mango chips and evaluate their quality. Freeze-dried mango chips are a popular snack that combines the natural sweetness and nutritional benefits of mangoes with the advantages of preservation through freeze-drying. This method effectively removes moisture while maintaining the fruit's flavor, color, and nutritional content, making it an appealing option for health-conscious consumers. The process involves optimizing parameters such as drying time and pressure to ensure high-quality products.

Materials and Methods

Uniform and fresh mature semi-ripe mango (Fazli) was collected from a commercial mango orchard of Bagha, Rajshahi. Several trial experiments were conducted using different pretreatments and freeze-drying time where drying temperature was fixed (-55^{o}C). The mangoes were washed, peeled, and sliced 3-5 mm thickness. Then slices were pretreated with different MD concentration such as 1.5%, 3%, 4.5% & 6% and without use of MD as a control treatment. Mango slices were soaked in MD solution for 10-15 mins and at least 1 hr. in other solutions. After pretreatments, the slices were packed in HDPE packet and stored in at -18^{o}C till frozen (~24-36 hrs.). The slices were dried in laboratory scale freeze dryer at -55^{o}C for 48-72 hrs. maintaining the vacuum pressure at 0.001 mBar. After drying, the chips were packed in laminated aluminum foil packet (~50 micron) and stored at room temperature (26±2^{o}C & 75±5% RH) in a dry and cool place. The moisture content was determined based on the AOAC official methods (AOAC, 2005). The titratable acidity and ascorbic acid content were determined following the methods of Ranganna (2007). All the obtained data were analyzed using IBM SPSS (Version 22.0, SPSS Inc., Chicago, IL) statistical software.

Results and Discussions

Table 1 provided the data on moisture content and titratable acidity for five different treatments, including a control treatment (T_1) and varying concentrations of MD (T_2 to T_5). Treatment T_1 (Control) exhibited the highest moisture at 9.77%. Treatment T_2 (1.5% MD) and treatment T_3 (3% MD) found moisture 8.41% and 9.42%, respectively. Treatment T_4 (4.5% MD) presented a significant reduction ($p<0.05$) in moisture to 7.37%. Treatment T_5 (6% MD) had the lowest moisture to 6.35%, which was significantly different from treatment T_1, T_2 and T_3. In Table 1, it was observed that increasing MD concentration (from treatment T_2 to T_5) generally led to a decrease trend of moisture content. This could be due to the hygroscopic nature of MD, which absorbs moisture, thereby reducing the overall water content in the samples.

In case of titratable acidity, treatment T_1 (Control) found the highest titratable acidity at 2.41%. Treatment T_2 (1.5% MD) and treatment T_3 (3% MD) were significantly lower ($p<0.05$) titratable acidity levels compared to control treatment T_1. Treatment T_4 (4.5% MD) and treatment T_5

(6% MD) exhibited intermediate titratable acidity levels (1.40% & 1.55%, respectively), which were significantly different from treatment T_1, T_2 and T_3.

In case of the phenolic content, with addition of MD up to 3% (9.19 mg GAE/100g), it slightly decreased in treatment T_4 (8.32 mg GAE/100g) and treatment T_5 (7.57 mg GAE/100g), similar to treatment T_2. Treatment T_3 (3% MD) was the most effective ($p<0.05$) in enhancing phenolic content. The antioxidant activity varies among treatments, with treatment T_2 (58.09%) and treatment T_5 (56.18%) had the highest inhibition percentages, indicating strong antioxidant properties.

The energy value changed with varied concentrations of MD. Treatment T_4 had the lowest energy value (553.07 kcal/100g), while treatment T_5 had the highest (579.79 kcal/100g). This variation indicated that different concentrations of MD affected the caloric content of the samples.

Conclusion

It can be concluded that 6% MD treated mango chips exhibited better quality in terms of physical appearance and nutritional quality in metalex foil packet. Improper freeze-drying of mango chips the product may reduce its crispiness or increase moisture of the product.

Table 1. Physicochemical properties of freeze-dried mango chips initially after processing

Treatment	Moisture (%)	Titratable acidity (%)	Total phenol (mg GAE/100g)	Antioxidants (% inhibition)	Energy (Kcal/100g)
T_1	9.77±0.87 a	2.41±0.05a	5.79±0.04a	38.65±0.21b	564.13±1.97b
T_2	8.41±0.30 ab	0.57±0.12c	7.56±0.02b	58.09±0.57b	555.53±1.85b
T_3	9.42±0.02 a	0.52±0.06c	9.19±0.02b	25.67±0.37c	571.91±1.33b
T_4	7.37±0.51 b	1.40±0.05b	8.32±0.03a	33.35±0.60a	553.07±1.48a
T_5	6.35±1.52 c	1.55±0.04b	7.57±0.03c	56.18±0.96c	579.79±2.22c

Values are Mean ± SD (n=3); Means followed by different lowercase letters in each differed significantly ($P<0.05$) among the treatments. Note: T_1=Control; T_2=1.5% MD; T_3= 3% MD; T_4= 4.5% MD; and T_5= 6% MD; MD=maltodextrin

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PHYSICOCHEMICAL PROPERTIES AND BIOACTIVE COMPOUNDS OF COFFEE BEAN AND COFFEE POWDER AT MADHUPUR OF TANGAIL

M.G.F.CHOWDHURY, M.H.H. KHAN, M.A. HOSSAIN, R. ISLAM

Abstract

This study examines the physicochemical composition and nutritional properties of selected coffee bean and coffee powder. Coffee bean and coffee powder were collected from Madhupur, Tangail and transferred to PHTD Lab, BARI, Gazipur. Physicochemical and bioactive compounds were evaluated through laboratory analysis. The results revealed that moisture content, ash, total soluble solids (TSS) and calorific value were found 8.76%, 2.81%, 2.93°B, 757 Kcal/100g, respectively in raw coffee beans and 2.68%, 1.89%, 2.97°B, 795 Kcal/100g, respectively after roasting. From coffee beans to roasting, anthocyanin content were observed from 0.29 mg/100g to 0.90 mg/100g and beta-carotene from 18.42 mg/100g to 32.21 mg/100g, pH levels became stable to 6.76 and the total carotenoid content ranged from 2.72 to 2.34 mg/100g. In conclusion, the findings underlined that roasting coffee beans induced a significant transformations affecting their chemical composition, flavor, and health benefits which provide insights into optimizing roasting processes to enhance desired qualities.

Introduction

Coffee (*Coffea*) species, widely distributed across tropical and subtropical regions, play a crucial role in both the global and national economy. Coffee places second in global trade after petroleum, providing incomes for over 20 million families across more than 50 countries (Freitas *et al.,* 2024). The most two species *Coffea arabica* (about 70%) and *Coffea canephora* (30%) are cultivated of the total coffee production in the world. Some people in Madhupur Upazila in Tangail regions have already started growing coffee on small scale and earning money, more people are being encouraged to grow coffee (Rahman *et al.,* 2024). For this purpose, nutritional profiling of this cultivated coffee should be emerged. Therefore, the study were conducted to assess selected coffee bean and coffee powder for evaluating the physicochemical properties and bioactive compounds.

Materials and Methods

Coffee bean and coffee powder were collected from Madhupur, Tangail and transferred to PHTD Lab, BARI, Gazipur. Moisture, ash, titratable acidity, vitamin C, anthocyanin, pH, total soluble solids (TSS) and calorific value were determined based on the AOAC official methods (AOAC, 2005). The titratable acidity and vitamin C content were determined following the methods of Ranganna (2007). Beta-carotene and total carotenoids were determined by the methods of Lee and Castle (2001) with some modifications. All the obtained data were analyzed using IBM SPSS (Version 22.0, SPSS Inc., Chicago, IL) statistical software.

Results and Discussions

The study analyzed the chemical properties of selected coffee bean and coffee powder before and after roasting. A significant ($p<0.05$) decrease in moisture content was observed, from 8.76% in raw beans to 2.68% after roasting, which is expected due to the high temperatures involved in roasting that drive off water. The ash content decreased from 2.81% in raw beans to 1.89% in roasted coffee, while the total soluble solids (TSS) showed a minimal increase from 2.93 ^{o}B to 2.97^{o}B, indicating that roasting slightly affects the soluble solids that contribute to coffee's flavor and aroma. Anthocyanin content which has antioxidant properties, increased from 0.29 mg/100g to 0.90 mg/100g. The calorific value (Energy) increased from 756.91 Kcal/100g in raw beans to 794.84 Kcal/100g after roasting, probably due to moisture loss and chemical transformations such as Maillard reactions that make some compounds more caloric (Table 1). However, Vitamin C content significantly decreased from 21.60 mg/100g in raw beans to 10.21 mg/100g in roasted coffee. The pH levels remained stable, with a slight increase from 6.76 to 6.77. Besides, the titratable acidity increased significantly from 0.61% to 1.85%, indicating a higher acid profile in roasted coffee. Beta-carotene (precursor to Vitamin A), increased from 18.42 mg/100g to 32.21 mg/100g. In contrast, the total carotenoid content slightly decreased from 2.72 mg/100g to 2.34 mg/100g after roasting (Table 2).

Conclusion

The roasting process leads to various chemical changes in coffee beans, including moisture reduction, changes in antioxidant compounds, and variations in energy and nutrient content. These transformations affect the coffee's flavor, aroma, and health-related properties.

Table 1. Physiochemical properties and bioactive compounds of coffee bean and coffee powder (roasted) grown in Madhupur, Tangail

Types	Moisture (%)	Ash (%)	TSS (°Brix)	Anthocyanin (mg/100g)	Energy (Kcal/100g)
Bean	8.76±0.05a	2.81±0.10a	2.93±0.06a	0.29±0.03b	756.91±2.63b
Roasted	2.68±0.02b	1.89±0.12b	2.97±0.21a	0.90±0.03a	794.84±5.26a

Average value ± Standard deviation (n= 3). Values followed by the same letter in the same line do not differ significantly ($p<0.05$)

Table 2. Nutritional profile of coffee bean and coffee powder (roasted) grown in Madhupur, Tangail

Types	Vitamin C (mg/100g)	pH	Titratable acid (%)	Beta-carotene (mg/100g)	Total carotenoid (mg/100g)
Bean	21.60±1.92a	6.76±0.07a	0.61±0.05b	18.42±1.13b	2.72±0.26a
Roasted	10.21±1.36b	6.77±0.08a	01.85±0.07a	32.21±3.31a	2.34±0.48a

Average value ± Standard Deviation (n= 3). Values followed by the same letter in the same line do not differ significantly ($p<0.05$)

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CONSUMERS PREFERENCE AND COMPARISON OF NUTRITIONAL QUALITY OF SELECTED FRESH-CUT VACUUM FRIED CHIPS IN SELECTED LOCATIONS OF BANGLADESH

M.G.F. CHOWDHURY, M.M. RAHMAN, M.H.H. KHAN, M.M. MOLLA, R.ISLAM

Abstract

The assessment was conducted to evaluate the consumer preference of selected vacuum fried (VF) chips and comparison of nutritional quality of existing real chips at selected locations of Bangladesh for improving quality to marketable the products. Jackfruit, banana, mango and potato were tested by the entrepreneurs at Rajshahi, Tangail, Bogura and Jashore. Jackfruit, banana and potato chips were accepted for marketable except mango chips require a bit improvement for color, crispiness and proper seasoning. The energy values were found a ranged from 480 to 577.52 Kcal/100g and acrylamide were observed also below TDI.

Introduction

Different chips available in the market are from secondary sources viz. dough and deep fried in oil with as high temperature as around 230°C. Consumers are suspicious of snacks with high temperature deep oil fried as current research shows these snacks may contain carcinogenic substances like acrylamide. BARI developed low-cost VF machine and product protocol are applicable to produce quality snacks. For familiarizing and quality improvement of VF chips, it needs to assess the products by the stakeholders.

d consumers.

Materials and Methods

The organoleptic test was conducted to assess VF jackfruit, banana, mango and potato chips by the entrepreneurs at Rajshahi, Tangail, Bogura and Jashore. Ten experts panel members were participated for the study and nutritional quality were examined both entrepreneurs developed and existing market sample of real chips. Nutritional qualities were analyzed both in PHTD, BARI and Waffen Research Lab, Dhaka.

Results and Discussions

Jackfruit chips was the most favored chips among consumers group in most locations, particularly in Rajshahi, Tangail, and Bogura. They received the highest scores in several sensory attributes, including color (8.4), taste (8.2), flavor (8.4), and overall acceptance (8.4). However, in Jashore, the scores were moderate, ranging from 7.6 to 7.8 across all attributes, indicating a slightly lower preference.

Banana chips observed a generally favorable response, especially in Tangail, where they were highly rated in taste (8.7), flavor (8.6), crispiness (8.6), and overall acceptance (8.6). It also performed well in Bogura with overall acceptance at 8.4, although the crispiness was rated slightly lower at 8.1. Rajshahi consumers rated the color (8.5), flavor (8.4), and overall acceptance (8.6) highly but gave lower scores for taste (6.4) and crispiness (6.8). In Jashore, banana chips received moderate ratings in taste (8.0) and flavor (7.8), but lower in oiliness (7.4) and overall acceptance (7.6), reflecting a mixed response.

Mango chips consistently received lower scores across most locations. Rajshahi consumers gave low scores for taste (6.8), flavor (6.6), and overall acceptance (7.2). In Tangail, the scores were mixed, with a high rating for flavor (8.0) and crispiness (8.2) but lower for taste (6.5). Overall acceptance was moderate at 8.2. In Bogura, mango chips received the lowest scores, particularly for color (6.4), taste (6.4), and overall acceptance (6.9). In Jashore, the chips scored moderately to well, with taste (7.4) and overall acceptance (7.6).

Potato chips was varying levels of acceptance, with Bogura group rated the strongest preference and Jashore the weakest. In Rajshahi, potato chips scored moderately across all attributes, with overall acceptance at 7.8. Tangail consumers gave high ratings for taste (8.3) and oiliness (8.1) but lower scores for color (6.9). In Bogura, potato chips were well-received, with consistent scores ranging from 8.2 to 8.4. In Jashore, they received lower ratings across several attributes, with taste (7.6) and crispiness (7.0) being the most notable, indicating a less favorable.

Table 1. Sensory evaluation of different VF chips by entrepreneurs at different locations of Bangladesh

Location	Chips	Color	Taste	Flavor	Crispiness	Oiliness	OA	Comment
Rajshahi	Jackfruit	8.4±0.89a	8.2±0.83a	8.4±0.89a	8.0±0.71a	8.00±0.71a	8.4±0.89a	Excellent
	Banana	8.5±0.83a	6.4±0.70b	8.4±0.89a	6.8±0.83b	8.2±0.83a	8.6±0.89a	Excellent
	Mango	7.2±0.83b	6.8±1.10b	6.6±1.52b	7.2±0.83b	7.2±0.83a	7.2±0.83a	Need improve.
	Potato	7.4±1.00a	7.8±0.00b	7.8±1.26b	7.6±1.00a	8.0±0.82a	7.8±0.00b	Need improve.
Tangail	Jackfruit	8.4±0.89a	8.5±0.50a	8.4±0.89a	8.4±0.89a	8.2±0.83a	8.2±1.09a	Better
	Banana	7.0±0.55b	8.7±0.44a	8.6±0.55a	8.6±0.54a	8.6±0.54a	8.6±0.55a	Better
	Mango	7.8±0.84a	6.5±0.89b	8.0±1.22a	8.2±0.83a	7±0.55a	8.2±0.83a	Good

Bogura	Potato	6.9±0.71b	8.3±0.97a	8.0±1.00a	8.00±1.00a	8±1.00a	8.3±0.67a	Good
	Jackfruit	8.5±0.54a	8.4±0.54a	8.4±0.55a	8.4±0.54a	8.4±0.45a	8.4±0.54a	Excellent
	Banana	8.0±0.71a	8.2±0.44a	8.2±0.44a	8.1±0.54a	8.3±0.44	8.4±0.54a	Excellent
	Mango	6.4±0.54cb	6.4±0.55b	6.8±0.44b	6.8±0.45c	6.6±0.44b	6.9±0.22c	Need improve.
Jashore	Potato	8.2±0.83	8.2±0.84a	8.2±0.84a	8.2±0.82a	8.4±0.54a	8.3±0.83a	Good
	Jackfruit	7.6±0.89b	7.8±0.44b	7.4±0.54b	7.8±0.44b	7.6±0.55b	7.6±0.89b	Excellent
	Banana	7.8±0.81b	8.0±0.82a	7.8±0.82b	7.6±0.50b	7.4±0.57a	7.6±0.50b	Need improve.
	Mango	7.0±0.95b	7.4±0.82a	7.8±0.57b	7.4±0.82b	7.2±0.00a	7.6±0.57b	Need improve.
	Potato	7.8±0.83a	7.6±0.55b	7.4±0.89b	7.0±0.71b	7.2±0.45b	7.4±0.55b	Good

Values are mean±standard deviation of 5 responses; Different lowercase letters in each column are differed significantly among the samples. Note: 1. Dislike extremely; 2. Dislike very much; 3. Dislike moderately; 4. Dislike slightly; 5. Neither like nor dislike; 6. Like slightly; 7. Like moderately; 8. Like very much; 9. Like extremely; OV=Overall Acceptability

Table 2. Nutritional composition of BARI developed vacuum fried different Fresh-cut chips

Parameters	Jackfruit chips	Mango chips	Banana chips
Energy KCal	480.00	507.41	503.85
Total Fat g	17.00	36.13	25.09
Trans Fat g	Absent	Absent	Absent
Saturated Fat g	5.50	0.10	10.53
Total Sugar g	1.00	3.93	4.39
Acrylamide µg	Absent	Absent	Absent
Starch %	17.80	0.10	20.51
Protein g	0.50	4.11	2.20
Vitamin C mg	28.60	50.20	15.23
Vitamin A mg	7.97	0.20	0.04
Dietary Fiber g	2.40	2.98	4.00
Carbohydrate g	26.50	51.01	29.00
Potassium mg	90.00	379.87	419.95
Iron mg	3.50	0.90	1.30
Calcium mg	15.00	36.88	10.88
Magnesium mg	8.00	39.01	9.50

Table 3. Comparison of the nutritional quality of selected potato chips

Parameters	VF potato chips	Lay's potato chips	Alooz potato chips	Sun chips
Energy KCal	577.52	544.00	-	544.00
Total Fat g	39.14	35.26	25.52	37.82
Trans Fat g	-	0.10	-	-
Saturated Fat g	-	14.80	-	-
Total Sugar g	6.75	3.73	4.84	3.65
Acrylamide ppm	77.50 (Below TDI)	ND	ND	ND
Starch g	40.33	-	-	-
Protein g	6.83	6.60	-	7.00
Carbohydrate g	49.49	57.70	-	54.00
Sodium mg	261.25	697.00	-	-
Iron mg	1.29	-	-	-
Magnesium mg	51.64	-	-	-
Dietary fiber g	3.73	-	-	-

ND: Not detected; TDI: Total Daily Intake

Conclusion

Jackfruit, banana and potato chips were mostly accepted by the entrepreneurs for marketable. Mango chips require a bit improvement for appearance, crispiness and proper seasoning. The energy values were found a ranged from 480 to 577.52 Kcal/100g and acrylamide were observed also below TDI.

EFFECT OF DIFFERENT ORGANIC ACIDS ON FERMENTATION OF VEGETABLES AND POMACES AS PROBIOTIC PICKLE

M.M. Molla, M.H.H. Khan, B.C. Dey, M.G.F. Chowdhury, S. Pervin and P. Sen

Abstract

The present investigation was undertaken to find out the effect of organic acids for long time preservation of vegetables and enhances fermentation of the stored vegetables under different strain of the selected bacteria. But no data on fermentation were recorded due to time limitation. The vegetables were treated with three different organic acids namely lactic acid, acetic acid and apple cider vinegar with 3 replications. The experiment was laid out in complete randomized design (CRD). The vegetables treated with different organic acids were shelf stable during storage (6 months more). Results indicate that the acidity level of the stored vegetables was increased whereas the vitamin C, β-carotene and pH was drastically decreased over the storage periods. The highest vitamin C and β-carotene content was retained by the apple cider vinegar.

Introduction

Vegetables and fruits are rich sources of nutrients, including vitamins; trace minerals, dietary fiber and many other elements required for growth and development of individual. After collection/processing of vegetables, the edible and inedible portions are rejected as wastage called pomace. Pomace is the rich source of antioxidants and other phytochemicals. On the other hand, the massive production of pomace is difficult to dumping in a place. Likely it pollutes the environment. But vegetables and probiotic pickles have protective role in the prevention of coronary heart disease, chronic obstructive pulmonary diseases, cataract formation, and diverticulosis through produce probiotic bacteria. These probiotic bacteria have been found to cure or inhabit cancer even HIV (Kahlon et al., 2007). Vegetables and pomaces preservation by fermentation technique may be one of the processes to preserve them for long time and make it as probiotic. Hence, it is urgent necessary to preserve the vegetable and pomaces for long time to utilize as vegetable curry and probiotic pickles.

Materials and Methods

Treatments

T_1= Lactic Acid
T_2= Acetic Acid and
T_3= Apple Cider Vinegar

Results and Discussion

pH and acidity: The pH and acidity of the vegetables was not significantly varied on the day and after storage. But after 6 months of storage the acidity was significantly differed, indicate that advancement of storage affects the acidity content of the vegetables.

Vitamin C and β-carotene: The highest vitamin C and β-carotene content was recorded in fresh vegetables but after 6 months of storage the vitamin C and β-carotene of the stored vegetables were drastically decreased (Table 3 and Table 4).

Table 1. pH of the fresh and stored vegetables

Treatment	Storage periods							
	On the day of storage				After 6 months of storage			
	Carrot	Cauliflower	Cabbage	Green pea	Carrot	Cauliflower	Cabbage	Green pea
T_1	7.30± 0.18	6.77± 1.06	6.47± 0.00	7.41± 0.21	4.17± 0.10	4.23± 0.49	4.05± 0.04	4.54± 0.03
T_2	7.30± 0.18	6.77± 1.06	6.47± 0.01	7.41± 0.21	4.26± 0.30	4.17± 0.02	3.99± 0.13	4.46± 0.32
T_3	7.30± 0.18	6.77± 1.06	6.47± 0.01	7.41± 0.21	4.08± 0.02	4.09± 0.11	4.15± 0.03	5.97± 1.32

All values represent the means of triplicate determinations ± standard deviation. Significant results ($p<0.05$) are indicated by means within columns. No letter means non-significant difference.

Table 2. Acidity of the fresh and stored vegetables

Treatment	Storage periods							
	On the day of storage				After 6 months of storage			
	Carrot	Cauliflower	Cabbage	Green pea	Carrot	Cauliflower	Cabbage	Green pea
T_1	0.12±0.02	0.18±0.06	0.32±0.00	0.05±0.01	0.16±0.09	0.06±0.45b	0.28±0.02	1.22±0.18
T_2	0.12±0.02	0.18±0.06	0.32±0.00	0.05±0.01	0.32±0.14	0.92±0.11a	0.31±0.03	1.28±0.48
T_3	0.12±0.02	0.18±0.06	0.32±0.00	0.05±0.01	0.29±0.18	0.52±0.04b	0.35±0.05	0.69±0.64

All values are means of triplicate determinations ± SD. Means within columns with different letters a, b indicate significant result ($p<0.05$). No letter means non-significant difference.

Table 3. Vitamin C of the fresh and stored vegetables

Treatment	Storage periods							
	On the day of storage				After 8 months of storage			
	Carrot	Cauliflower	Cabbage	Green pea	Carrot	Cauliflower	Cabbage	Green pea
T_1	9.31±0.10	44.24±1.91	14.11±0.00	38.35±0.84	5.56±0.14c	8.48±0.68c	5.13±1.33b	13.50±0.53c
T_2	9.31±0.10	44.24±1.91	14.11±0.00	38.35±0.84	6.86±0.02b	9.27±0.67b	4.35±0.00c	14.13±0.59b
T_3	9.31±0.10	44.24±1.91	14.11±0.00	38.35±0.84	8.13±0.03a	11.07±1.18a	6.35±0.00a	16.83±0.07a

All values represent the means of triplicate determinations ± standard deviation. Means within columns with different letters a, b indicates significant result ($p<0.05$). No letter means non-significant difference.

Table 4. β-carotene of the fresh and stored vegetables

Treatment	Storage periods							
	On the day of storage				After 6 months of storage			
	Carrot	Cauliflower	Cabbage	Green pea	Carrot	Cauliflower	Cabbage	Green pea
T_1	63.15±2.05	13.68±0.80	12.84±0.00	53.80±1.09	38.97±5.10	12.07±0.83	11.29±0.79ab	40.41±16.04ab
T_2	63.15±2.05	13.68±0.80	12.84±0.00	53.80±1.09	34.83±2.70	10.95±1.79	9.39±1.04b	27.77±0.60b
T_3	63.15±2.05	13.68±0.80	12.84±0.00	53.80±1.09	41.56±5.05	12.80±0.87	12.38±0.32a	51.33±1.09a

All values represent the means of triplicate determinations ± standard deviation. Means within columns with different letters a, b indicates significant result ($p<0.05$). No letter means non-significant difference.

Conclusion

The vegetables preserved with different organic acids were not deteriorated up to the reporting period (6 months more). All the acids were favorable for preservation of vegetables but the maximum vitamin C and β-carotene retained by the apple cider vinegar.

Acknowledgement

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EFFECT OF SALT CONCENTRATION ON PRESERVATION OF VEGETABLES AS PROBIOTIC PICKLE

M.M. Molla, M.H.H. Khan, B.C. Dey, S.Pervin, M.G.F. Chowdhury and M.M.Rahman

Abstract

The purpose of the study was to find out the proper concentration of salt for long time preservation of vegetables. There were three treatments with 3 replications and the experiment was laid out in complete randomized design (CRD). The vegetables treated with different salt concentration were stored for 12 months in food grade plastic container at ambient condition. Results confirm that vegetables treated with 4 %, 6 % and 8 % salt concentration slightly penetrated into the vegetables whereas most of the salt were present into H_2O solution. Vegetable treated with 4% salt under cooking condition was acceptable by the panelist.

Introduction

Vegetables are rich sources of phytochemicals, vitamins; trace minerals, dietary fiber with its protective role in the prevention of coronary heart disease, chronic obstructive pulmonary diseases, cataract formation, and diverticulosis through produce of probiotic bacteria. Generally, fruits are preserved using 10% brine solution. Information on preserving vegetables using brine solution following steeping method for more than 12 months are meager in the world. Recently a trial was conducted using 10 % salt concentration found salty for preserving vegetables. Hence, the present study was conducted to determine the proper concentration of salt for preserving vegetables more than 12 months and its acceptability under curry and salad condition as well as multi uses in the vegetable processing area.

Materials and Methods

Collection and pre-processing of vegetables: Fresh selected vegetables were collected from the local market of Gazipur. The collected vegetables were pre-cooled, sorted and graded. Then the vegetables were trimmed and treated according to the following treatments.

Treatments

T_1= 4 % salt + 0.10 % acetic acid + 0.01% KMS+ 94.90 % H_2O
T_2= 6 % salt + 0.10 % acetic acid + 0.01% KMS+ 92.90 % H_2O
T_3= 8 % salt + 0.10 % acetic acid + 0.01% KMS+ 90.90 % H_2O

Results and Discussion

Color changes of the stored vegetables

Color is the foremost quality considered by consumers at the time of purchasing a product. The effect of storage on color changes of fresh and stored vegetables is shown in Table 1. The lightness (L^*) of the fresh carrot, cauliflower, cabbage and green pea ranged from 51.26 to 51.38, 74.02 to 79.07, 79.07 to 79.35 and 51.08 to 53.53 whereas the stored vegetables ranged from 46.34 to 46.47, 58.78 to 63.66, 66.20 to 66.22 and 48.83 to 51.33 respectively, indicate that the lightness of the stored vegetables were gradually decreased but the decreasing tendency was not statistically differed (Table 1).The chroma (C^*) value of the stored vegetables were also insignificantly differed over the storage periods. The hue angle (h^*) of the fresh carrot, cauliflower, cabbage and green pea ranged from 52.40 to 52.56, 88.14 to 88.40, 93.04 to 93.40 and 97.29 to 99.50 whereas the stored vegetables ranged from 60.12 to 60.30, 90.90 to 91.99, 104.41 to 105.01 and 96.04 to 97.61 respectively. It is interesting that the hue angle (h^*) value of the stored vegetables was gradually increased entire the storage periods as compared to fresh vegetables.

Table 1. Color changes of the fresh and stored vegetables

Treatment		On the day of storage					After 6 months of storage				
		L	a	b	C	H	L	a	b	C	H
T_1	Carrot	51.26 ±0.06	36.03± 0.28	47.41± 0.10	59.71± 0.16	52.56± 0.08	46.41± 0.06	36.22± 0.04	42.56± 0.27	55.88± 0.23	60.21 ±0.06
	Cauliflower	74.48 ±2.78	0.60± 0.01	22.84± 0.25	22.85± 0.25	88.40± 0.17	63.66± 2.44	0.32± 0.16	20.50± 1.06	20.51± 1.06	91.99 ±0.54
	Cabbage	79.07 ±0.14	-1.03± 0.04	17.41± 0.07	17.44± 0.07	93.40± 0.18	66.20± 0.01	-7.48± 0.43	27.88± 1.09	28.86± 1.16	105.01 ±1.04
	Green pea	53.53 ±1.14	-3.32± 0.29	34.81± 0.70	35.09± 1.12	97.29± 1.10	51.33± 1.25	-4.32± 0.52	33.81± 0.91	34.09± 0.78	97.61 ±0.78
T_2	Carrot	51.37 ±0.06	36.42± 0.28	47.47± 0.10	59.83± 0.16	52.58± 0.08	46.34± 0.06	36.17± 0.04	42.29± 0.27	55.65± 0.23	60.12 ±0.06
	Cauliflower	74.02 ±2.71	0.73± 0.03	22.50± 0.25	22.51± 0.25	88.14± 0.17	58.78± 2.44	0.65± 0.16	18.38± 1.06	18.39± 1.06	90.90 ±0.54
	Cabbage	79.14 ±0.14	-0.96± 0.04	17.49± 0.01	17.52± 0.07	93.14± 0.18	66.22± 0.01	-6.61± 0.43	25.70± 0.91	26.53± 1.16	104.41 ±1.03
	Green pea	51.83 ±1.14	-3.37± 0.29	34.08± 0.70	36.53± 1.12	99.50± 1.10	48.83± 1.25	-5.37± 0.52	32.08± 0.91	32.53± 0.78	96.04 ±0.78
T_3	Carrot	51.38 ±0.06	36.59± 0.28	47.61± 0.10	60.04± 0.16	52.60± 0.08	46.47± 0.06	36.26± 0.04	42.83± 0.27	56.12± 0.23	60.30 ±0.06
	Cauliflower	79.07 ±2.79	0.66± 0.02	23.01± 0.26	23.01± 0.25	88.36± 0.17	61.22± 2.44	0.49± 0.16	26.79± 1.06	19.45± 1.09	91.45 ±0.54
	Cabbage	79.35 ±0.14	-0.94± 0.04	17.56± 0.07	17.59± 0.07	93.04± 0.18	66.21± 0.01	-7.05± 0.43	27.69± 1.16	27.69± 1.16	104.71 ±1.05
	Green pea	51.08 ±1.14	-3.85± 0.29	33.41± 0.07	34.31± 1.12	98.39± 1.10	50.08± 1.25	-4.85± 0.52	32.41± 0.91	33.10± 0.78	96.83 ±0.78

All values represent the means of triplicate determinations ± standard deviation.

Salt concentration and residue in vegetable

Table 2 represents the different salt concentration and their effects on residue of salt treated samples during storage. Results obtained from this study was statistically differed. The penetration of salt content using 4%, 6% and 8 % salt treated preserved carrot, cauliflower, cabbage and green pea ranged from 1.30-2.12 %, 1.80 % -2.62 % and 3.01-3.57 % whereas the salt remained in soluble H_2O ranged from 2.60-2.95 %, 3.83-4.63 % and 4.89-5.30 % respectively. Results indicate that the penetration of salt content into the vegetables entire the storage periods were lower than the used media (H_2O).

Table 2. Residue of salt concentration after 6 months storage of vegetables

Treatment	Carrot			Cauliflower		
	On the day of storage (%)	After storage		On the day of storage (%)	After storage	
		Salt in carrot (%)	Salt in H_2O (%)		Salt in carrot (%)	Salt in H_2O (%)
T_1	4.00±0.00	2.12±0.03c	2.95±0.05c	4.00±0.00	1.40±0.03c	2.91±0.05c
T_2	6.00±0.00	2.62±0.02b	3.83±0.03b	6.00±0.00	1.80±0.02b	4.63±0.03b
T_3	8.00±0.00	3.57±0.03a	5.30±0.05a	8.00±0.00	3.54±0.04a	4.89±0.03a
		Cabbage			Green Pea	
T_1	4.00±0.00	1.71±0.02c	2.60±0.02c	4.00±0.00	1.30±0.03c	2.87±0.02c
T_2	6.00±0.00	1.99±0.02b	4.23±0.03b	6.00±0.00	2.03±0.03b	4.10±0.03b
T_3	8.00±0.00	3.01±0.01a	5.25±0.05a	8.00±0.00	3.34±0.04a	4.91±0.02a

Conclusion

The vegetables preserved with 4% salt concentration was found less salty as compared to others.

Acknowledgement: The research was conducted by the financial assistance of the Ministry of Science and Technology, Bangladesh secretariat, Dhaka under the project ID: SRG 231056.

UTILIZATION OF PINEAPPLE POMACES TO DEVELOP BAKERY PRODUCTS (CAKE) FOR ITS PHYSICOCHEMICAL, NUTRITIONAL, TEXTURAL AND FUNCTIONAL PROPERTIES

M.M. Molla, M.H.H. Khan, B.C. Dey, S. Pervin, P. Sen, M.G.F. Chowdhury and M.A.Hossain

Abstract

The purpose of the study was to utilize the pineapple pomace to develop by-product especially pomace cake using different proportions of pomace flour. The study was laid out in complete randomized design (CRD) with five treatments and 3 replications. The developed cake was stored in pouches at ambient condition to observe nutritional changes, texture, color, shelf life and sensory attributes. Results check that 25-75 % pomace flour (T_2-T_4) was acceptable more by the panel members as compared to wheat flour (T_1). T_2-T_4 (25-75 % pomace flour) treated pomace cake found the best results to retain more nutritional compositions than control (T_1). These finding could be the best way to apply this technology by the agro-food processing industries for utilization of pineapple pomace as a by-product.

Introduction

Pineapple (*Ananas comosus*) is one of the most important fruits in the world and its juice is the 3rd most preferred worldwide after orange and apple juices (Cabrera et al., 2000). After extraction of juice (purpose of jelly preparation and other usage) from the fruit, the pulps are rejected as wastage. The increasing production of pineapple processed items results in massive waste generations called pineapple pomace. The drying, storage and shipment of this wastage is cost effective. Likely the pomace pollutes the environment. Hence efficient, inexpensive and eco-friendly utilization is becoming more and more necessary. Recently the pineapple pomace balls (laddu) have been developed by Molla et al. (2023). But its bakery products are still now meager in the globe. Therefore, an attempt has been undertaken to utilize the pineapple pomaces as bakery products that could contribute to minimize the postharvest loss of pineapple and mitigate the environmental pollution.

Materials and Methods

Collection and processing of pineapple pomace: Fresh pineapple was collected from the local market of Gazipur. The juice was extracted manually using juice extractor. The pineapple jelly was prepared using the juice and the pomace drying by cabinet dryer at 60ºC for 48 hours. Then the pomace flour was prepared by high speed grinder using mesh (40-60 no. of sieve). Then the flour was treated for preparation of cake according to the following treatments.

Treatments

T_1= 100 % wheat flour (control)
T_2= 25 % pineapple pomace flour + 75 % wheat flour
T_3= 50 % pineapple pomace flour + 50 % wheat flour
T_4= 75 % pineapple pomace flour + 25 % wheat flour
T_5= 100 % pineapple pomace flour

Results and Discussion

Nutritional composition of pineapple pomace cake

The nutritional compositions were significantly differed. Results show that cake formulation with different proportions of pomace flour contained more nutrition than cent percent wheat flour (Table 1).

Sensory evaluation of pineapple pomace cake

The sensory evaluation of the pineapple pomace cake was performed based on 9-point hedonic scale (Table 2). The score obtained by the expert judgment in terms of color, flavor, texture, taste and overall acceptability. Results revealed that highest score of the cake was gained by the T_4 treated pomace flour whereas the nearest value was recorded by the and T_2 treated pomace flour than others. Results obtained from the sensory evaluation confirm that the cake formulation with 75 % pomace flour (T_4) was acceptable by the judgement panel members than 100 % wheat flour (T_1). The members opined that T4 treated cake contained good natural flavor and taste than others whereas its color and texture may be improved.

Table 1. Nutritional composition of pineapple pomace cake

Treatment	Vitamin C (mg/100 g)	β-carotene (mg/100 g)	Total sugar (%)	TSS (ºB)	Acidity (%)	pH	Moisture (%)
T_1	0.58±0.02e	15.35±0.35d	17.95±0.05e	36.40±0.20e	0.32±0.04bc	9.73±0.07	13.30±0.30e
T_2	5.82±0.04d	20.47±0.47c	27.03±0.03d	63.70±0.10d	0.48±0.02a	7.58±0.12	15.14±0.14f
T_3	11.76±0.04c	20.86±0.14c	31.85±0.15c	67.40±0.30c	0.26±0.04bc	7.55±0.15	18.88±0.12c
T_4	13.23±0.10b	23.70±0.10b	32.90±0.10b	70.10±0.10b	0.22±0.03cd	7.40±0.20bc	25.04±0.04b
T_5	14.71±0.09a	28.26±0.26a	34.97±0.03a	73.60±0.10a	0.16±0.04	7.13±0.13c	26.64±0.05a

All values are means of triplicate determinations ± SD. Means within columns with different letters a, b, c, d, e, f indicate significant result ($p<0.05$).

Table 2. Sensory evaluation of pineapple pomace cake on the day of storage

Treatment	Sensory attributes				
	Color	Flavor	Texture	Taste	Overall acceptability
T_1	6.67±2.30	6.00±1.00	6.67±1.00	7.00±1.73	6.58±1.42
T_2	7.00±1.00	7.00±1.00	7.67±0.57	7.67±0.57	7.33±0.28
T_3	6.67±0.57	7.00±0.00	7.00±0.00	7.00±1.00	6.91±0.38
T_4	7.00±0.00	7.67±0.57	7.33±1.15	8.00±1.00	7.50±0.43
T_5	6.33±0.57	6.33±0.57	6.33±0.57	7.00±1.00	6.50±0.50

All values are means of triplicate determinations ± SD. No letter means non-significant difference.

Color of the formulated pomace cake

Color is the foremost quality considered by consumers at the time of purchasing a product. The ratio of wheat flour affects the color changes of the pomace cake. The wheat flour treated cake shows brightness but the pomace flour treated cake shows the natural color of the pineapple (Fig. 1). Hence the 25-75 % pomace flour treated cake gained maximum score by the sensory evaluator (Table 1).

Fig. 1 Color of the formulated pomace cake

Conclusion

The cake formulation with 25-75 % pomace flour (T_2-T_4) found best formulation in terms of nutritional composition. All the sensory evaluator opined their positiveness to utilize the pomace flour as cake.

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DEVELOPMENT OF MIXED DRY FRUIT PRODUCTS AND ITS PACKAGING TECHNIQUE

M.M. Molla, M.H.H. Khan, B.C. Dey, P. Sen, S. Pervin and M.G.F. Chowdhury

Abstract

The study explored to develop mixed dry fruit using blanching, sugaring and sulphuring process. The study was laid out in complete randomized design (CRD) with three treatments (T_1, T_2 and T_3) and replications. The developed mixed dry fruit was stored in food grade mini plastic boxes at ambient condition to observe microbial studies, nutritional and changes, shelf life and sensory attributes. Results reveal that blanching and sugaring treated fruit (T_1) lost their vitamin C and β-carotene content than others. The sugar treated fruit found to be maximum total and reducing sugar content than others whereas it was gained maximum score by the sensory evaluator. Blanching and sugaring improved the fruit color than others. But the texture of the fruit found to be maximum hardness that was not acceptable by the evaluator. Hence, further study needs to be continued to make its suitable texture and maximum shelf life without deterioration any quality.

Introduction

Drying is one of the oldest methods of food preservation. It is still used widely to preserve foods for home consumption and for sale. Recently dried fruits are one of the most popular products made by small-scale processors. Bangladesh is the most leading fruit producing country in the world. But its postharvest loss ranged from 23.60-43.50 % (Hasan et al., 2010) due to lack of proper processing and preservation techniques. Drying removes the water from the fruit so that the growth of microorganism is inhibited. It reduces the weight and bulk of foods which cuts down on transport and storage costs. Smart drying process viz. microwave vacuum drying, spray drying and freeze drying is used in the world to dry foods. In recent, different Bangladeshi importers are importing the dry mixed fruit from the Malaysia, Vietnam, Thailand, Italy, China and so on. As a result Bangladesh is losing their reserved currency. From the point of minimization of fruit lose and foreign currency ($), the present study has been undertaken to produce shelf stable mixed dry fruit with retains their nutritional properties and maximum marketability.

Materials and Methods

Materials: Papaya, ber, radish and lemon peel.

Collection and processing of mixed dry fruit: Fresh fruits were collected from the local market of Gazipur. Then the fruit was prepared according to the following treatments.

Treatments

T_1= Blanching + sugaring; T_2= Blanching + sulphiting; T_3= without blanching + sugaring + sulphiting (control)

Results and Discussion

Nutritional composition of the mixed dry fruit

The nutritional composition of the mixed dry fruit was highly significant different (Table 1). Results show that control mixed dry fruit (T_3) contained a lower amount of nutritional composition than others. But the maximum vitamin C and β-carotene was found in the control mixed dry fruit (T_3). The blanching and heating process by the treatment T_1 might be contributed to achieve lower amount of vitamin C and β-carotene than control (T_3).

Color of the mixed dry fruit

Color is one of the important quality attributes for consumer acceptability of foods, particularly for fresh and processed fruits and vegetable products (Molla et al., 2022). In this study, the color values were recorded as L* (light), C* (croma) and H* (hue angle). All the values were found to be statistically significant different. The maximum C* value obtained by the T1, indicates the colorfulness of the product used to measure the variance of a hue in contrast to a grey color by a similar lightness. The highest H* values was found to be maximum in treatment T_1, indicating that the product was within 180^o and 270^o region with attractive color (Molla et al., 2022).

Texture of the mixed dry fruit

Fig.1 shows the textural properties as well as rupture forces (FR) of the mixed dry fruit. Results indicate that all the treated fruits were found to be maximum hardness while it was slightly disliked by the panel of judges.

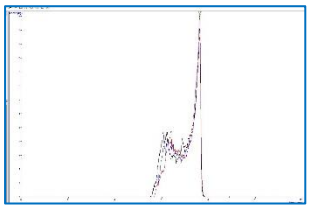

Fig. 1. Texture of the mixed dry fruit

Sensory evaluation of the mixed dry fruit

There were insignificant differences among the dry mixed fruit (Table 3). But the maximum score was gained by the blanching and sugaring of the fruit (T_1) than without sugaring (T_2) and control (T_3).

Table 1. Nutritional composition of the mixed dry fruit

Treatment	Total sugar (%)	Reducing sugar (%)	TSS (°B)	Vitamin C (mg/100 g)	β -carotene (mg/100 g)	Acidity (%)
T_1	38.10±0.10a	31.25±0.25a	3.85±0.05	4.70±0.10b	4.30±0.15a	0.83±0.07
T_2	36.23±0.23b	26.31±0.31b	3.77±0.03	4.72±0.08b	3.65±0.65b	0.70±0.10
T_3	34.02±0.20c	24.51±0.40c	3.75±0.10	7.06±0.06a	4.43±0.07a	0.76±0.04

All values are means of triplicate determinations ± SD. Means within columns with different letters a, b, c indicate a significant result ($p<0.05$). No letter means non-significant difference.

Table 2. Color of the mixed dry fruit

Treatment	L*	C*	H*
T_1	54.79±2.99b	44.78±1.97a	115.18±3.10a
T_2	56.87±0.71b	41.54±1.91a	93.410.63b
T_3	69.63±3.10a	30.37±2.83b	85.37±0.45b

All values are means of triplicate determinations ± SD. Means within columns with different letters a, b, c indicate a significant result ($p<0.05$).

Table 3. Sensory evaluation of the mixed dry fruit

Treatment	Sensory attributes				
	Color	Flavor	Softness	Taste	Overall acceptability
T_1	7.00±1.00	7.00±1.00	6.80±0.57	7.50±0.57	7.05 ± 1.10
T_2	6.50±2.30	6.30±1.00	6.20±1.00	7.30±1.73	6.58 ± 1.00
T_3	6.37±0.57	6.70±0.00	6.10±0.00	7.40±1.00	6.64 ± 0.08

All values are means of triplicate determinations ± SD. No letter means non-significant difference.

Conclusion

Further study should continue to find out the effective way to make the suitable hardness and maximum shelf life of the products.

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PRESERVATION OF BARI MOTORSHITI 1 BY APPLICATION OF HURDLE TECHNOLOGY

M.M. Molla, M.H.H. Khan, B.C. Dey, S. Pervin, P. Sen and M.G.F. Chowdhury

Abstract

The present study was undertaken to find out the effect of hurdle technology to preserve the BARI Motorshuti 1 for long time. The harvested motorshuti were treated with four treatments and 3 replications. The experiment was laid out in complete randomized design (CRD). Results revealed that the vitamin C level of the stored motorshuti were increased after application of hurdle technology although a decreasing tendency was found to be maximum in treated motorshuti than control. Total soluble solid (TSS), total sugar (TS), reducing sugar (RS) and pH of the motorshuti increased with the advancement of storage periods.

Introduction

Canning is the process of placing foods in jars or cans and heating properly to a specified temperature is a way to preserve many different foods. The high heat destroys microorganisms and inactivates enzymes to preserve the safety and quality of the food. BARI Motorshuti is a seasonal and high value crops in Bangladesh. Its shelf life is very limited due to its high perishability nature. Still now, a little information is meager to process and preserve the BARI Motorshuti 1 for longtime in the country. Traditionally, UV irradiation has been used for water treatment, surface decontamination, and air disinfection with limited food-related applications. The use of UV irradiation for applications in the food industry has seen increased interest in the last two decades. Studies have demonstrated UV irradiation's potential to inactivate a wide range of microorganisms. UV irradiation has proven to be effective against viruses, parasites and vegetative cells and fungi (Duarte et al., 2022). Furthermore, UV irradiation has found to reduce the levels of mycotoxins and allergens. Hence, the present study has undertaken to develop canning technique for preservation of BARI Motorshuti 1 by application of UV treatment as a part of hurdle technology for longer, safe and quality products.

Materials and Methods

Materials: BARI Motorshuti 1

Treatments

T_1= Salt 1% + sugar 6 % + citric acid (CA) 0.05 % + potassium metabisulphite (KMS) 0.1 % (control)

T_2= Salt 1% + sugar 6 % + CA 0.05 % + KMS 0.1 % + Ascorbic acid (AA) 1 %

T_3= Salt 1% + sugar 6 % + CA 0.05 % + KMS 0.1 % + AA 1 % + Potassium sorbet (KS) 0.1 %

T_4= Salt 1% + sugar 6 % + CA 0.05 % + KMS 0.1 % + AA 1 % + KS 0.1 % + UV treatment

Results and Discussion

Physicochemical composition of BARI Motorshuti 1

Table 1 represents the physicochemical composition of BARI Motorshuti 1. All the compositions were insignificantly differed entire the storage periods except TSS. The TSS were significantly different on the day of storage and after 6 months of storage. Although the insignificant differences were observed but the pH, total sugar and reducing sugar of the stored motorshuti were increased over the storage periods.

Table 1. Physicochemical composition of BARI Motorshuti 1

Treat	TSS		pH		TS (%)		RS (%)	
ment	0D	6M	0D	6M	0D	6M	0D	6M
T_1	4.10±0.17	4.50±0.02b	4.35±0.02	4.37±0.02	0.66±0.01	0.68±0.01	0.25±0.01	0.28±0.02
T_2	4.10±0.17	4.79±0.07a	4.35±0.02	4.40±0.00	0.66±0.01	0.72±0.02	0.25±0.01	0.30±0.04
T_3	4.10±0.17	4.80±0.02a	4.35±0.02	4.40±0.02	0.66±0.01	0.73±0.01	0.25±0.01	0.31±0.02
T_4	4.10±0.17	4.78±0.02a	4.35±0.02	4.39±0.02	0.66±0.01	0.71±0.02	0.25±0.01	0.32±0.03

All values represent the means of triplicate determinations ± standard deviation. Means within columns with different letters a, b indicates significant result ($p<0.05$). No letter means non-significant difference.

Vitamin C of the BARI Motorshuti 1

The highest vitamin C content was recorded in fresh motorshuti and a non-significant difference were observed on the day of storage (Fig.1). After 6 months of storage the vitamin

C were drastically decreased. Results confirm that the addition of ascorbic acid and hurdle technology contributed to achieve the highest vitamin C content than control although a slight decreased vitamin C content was noted by the UV treatment. The UV light intensity might be denoted to reduce the vitamin C content.

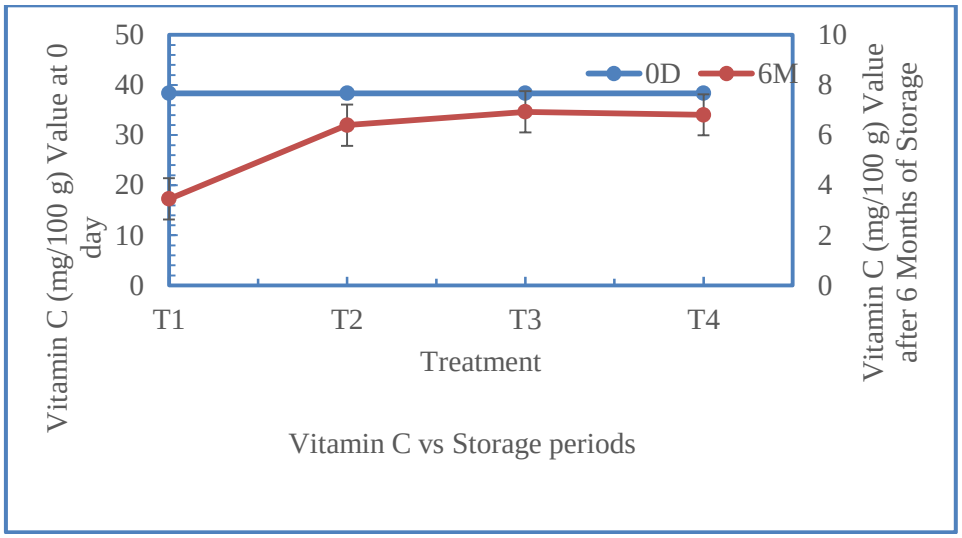

Fig.1. Effect of hurdle technology on retention of vitamin C

Shelf life of the stored BARI Motoshuti 1

The maximum shelf life (6 months more) of the BARI Motorshuti 1 was recorded by the application of hurdle technology than control (Fig. 2).

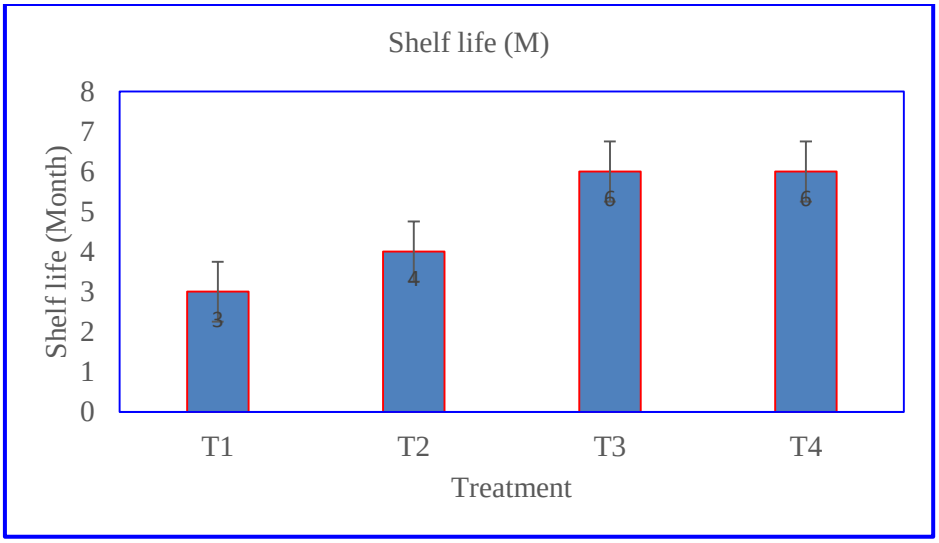

Fig2. Shelf life of BARI Motorshuti

Conclusion

The shelf life of BARI Motorshuti 1 could be extended 6 months more by application of hurdle technology without deterioration of quality.

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DEVELOPMENT OF LEMON JUICE BY APPLICATION OF THERMAL AND NON-THERMAL TREATMENTS

M.M. Molla, M.H.H. Khan, B.C. Dey, S. Pervin, M.G.F. Chowdhury, P. Sen and P.C Sarker

Abstract

The study explored to develop lemon juice by application of thermal and non-thermal UV treatment. The study was laid out in complete randomized design (CRD) with three treatments namely thermal treatment (T_1 and T_2) and non-thermal UV treatment (T_3) with 3 replications. The developed juice was stored in PET bottles at ambient condition to observe microbial studies, nutritional and bioactive compound analysis, shelf life and sensory attributes. Results reveal that all the treated juice contained bacteria, yeast and molds. No fungus was detected during the study periods. Control sample (T_1) contained highest nutritional composition than others. UV treated juice (T_3) contained higher vitamin C than pasteurized treatment (T_2). But increasing UV time decreased the vitamin C content. In opposition, the lower number of bacteria, yeast and molds was found by the pasteurized treated juice (T_2) than UV treated juice (T_3). Further observation needs to confirm the effect of pasteurization and UV treatment on microbial (bacteria, yeast and molds) and nutritional composition.

Introduction

Lemon (lebu) is a citrus fruit belongs to the family Rutaceae with its English name is Citrus limon. It is grown all over the Bangladesh, though their production is concentrated mainly in Sylhet, Chattagram and the Chattagram Hill Tracts. In 2020-2021, the total production of the lime and lemon was 81604.46 MT whereas its present production comprises 95411.89 MT, indicating that the production of the lemon is increasing year by year (BBS, 2023). But it is sorrow that the process products of lemon are still now meager in the country. Ultraviolet (UV) is an alternative to thermal pasteurization for a range of liquid foods and ingredients (fresh juices, soft drinks, raw milk, liquid eggs, liquid sugars and sweeteners, etc.). It is applied to reduce the most microorganisms of public health significance. The UV irradiation as an alternative to heat that can be used for pasteurization purposes (Supplement to JFP 2006). Although the use of UV light is well established for air and water treatment and surface decontamination, its use for treating liquid foods is still limited in the country. Hence the purpose of the present study was to develop lemon juice using thermal and UV treatment to find out the quality effects of treatment for long time preservation of lemon juice by inactivation of microorganisms (bacteria, fungus, yeast and molds).

Materials and Methods

Materials: Lemon **(**Citrus limon)

Collection and processing of lemon: Fresh lemon was collected from the local market of Gazipur. The juice was extracted using juice extractor. Then the juice was prepared according to the following treatments.

Treatments

T_1= Control; T_2= Pasteurized; T_3= UV treated

Results and Discussion

Nutritional composition and bioactive compounds of lemon juice

The nutritional and bioactive compounds were highly significant different (Table 1 and Table 2). Results show that control juice contained a highest amount of nutritional composition than others. UV treated juice (T_3) possessed a higher amount of vitamin C, β-carotene and total carotenoid than pasteurized juice (T_2).

Microbial counts of lemon juice

Table 3 represents the microbial studies of the developed and stored lemon juice. No fungal was detected entire the storage periods. But limited bacteria, yeast and molds were detected for the thermal and non-thermal treated juice. Even UV treated juice contained a limited number of bacteria, yeast and molds. The lemon and water used for the study, even instrumental error (UV light and time) might be the main source of bacteria, yeast and molds whereas the UV and pasteurized treatment could not inactivate the microorganism activities

Sensory evaluation of lemon juice

There were insignificant differences among the treated juice. But the maximum score obtained by the pasteurized (T_2) and UV treated juice (T_3) than control.

Table 1. Nutritional composition of lemon juice.

Treatment	TSS	pH	Acidity	Total sugar (%)	Reducing sugar (%)
T_1	41.10±0.10a	3.40±0.10	0.19±0.01b	24.01±1.00a	26.04±1.00a
T_2	32.30±0.10c	3.55±0.05	0.11±0.01c	18.84±0.16c	20.54±0.20c
T_3	35.93±0.66b	3.45±0.05	0.51±0.02a	20.54±0.54b	22.42±0.42b

All values are means of triplicate determinations ± SD. Means within columns with different letters a, b, c indicate a significant result ($p<0.05$). No letter means non-significant difference.

Table 2. Bioactive compounds of lemon juice

Treatment	Ascorbic acid (mg/100g)	β-carotene (mg/100 g)	Total carotenoid (mg/100 g)	Total phenol (mg GAE/g)	Anthocyanin (mg/100 g)
T_1	3.69±0.10a	15.56±0.30b	3.06±0.45a	6.59±0.10a	0.04±0.01ab
T_2	1.76±0.40c	14.87±0.13b	1.49±0.10b	6.35±0.35ab	0.07±0.02a
T_3	2.35±0.15b	20.04±1.00a	1.66±0.16b	6.01±0.01b	0.03±0.01b

All values are means of triplicate determinations ± SD. Means within columns with different letters a, b, c indicate a significant result ($p<0.05$).

Table 3. Microbial studies of the developed lemon juice

Treatment	Yeast and Molds (CFU/mL)	Bacteria	Fungus
T_1	$2.80 \times 10^3 \pm 0.05$a	$3.40 \times 10^5 \pm 0.05$a	ND
T_2	40.00 ±0.50c	38.00 ±0.50c	ND
T_3	$1.96 \times 10^3 \pm 0.04$b	$1.90 \times 10^5 \pm 0.10$b	ND

All values are means of triplicate determinations ± SD. Means within columns with different letters a, b, c indicate a significant result ($p<0.05$). No letter means non-significant difference.

Table 4. Sensory evaluation of lemon juice

Treatment	Sensory attributes				
	Color	Flavor	Texture	Taste	Overall acceptability
T_1	6.87±2.30	6.50±1.00	6.77±1.00	7.40±1.73	6.80±1.42
T_2	7.00±1.00	7.00±1.00	7.80±0.57	7.80±0.57	7.40±0.28
T_3	6.97±0.57	7.00±0.00	7.70±0.00	7.50±1.00	7.29±0.38

All values are means of triplicate determinations ± SD. No letter means non-significant difference.

Conclusion

The lemon juice was shelf stable up to 2 months. Further study should continue to find out the effective way to reduce the presence of bacteria, yeast and molds.

Acknowledgement

The research was conducted by the financial assistance of 'Smallholder Agricultural Competitiveness Project (SACP), BARI component.

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NUTRITIONAL, PHYSICOCHEMICAL AND BIOACTIVE COMPOUNDS ANALYSIS OF DEVELOPED FORTIFIED EXTRUDED LENTIL CHIPS

M.M.Molla, M.H.H.Khan, M.G.F. Chowdhury, S.Pervin, B.C.Dey, P.Sen, M.S.Zaman, P.Bhowmik and A.Khatun

Abstract

This study sought to explore the fortification of the developed lentil chips using hot extrusion technology. There were five treatments viz. developed chips without fortification (control sample: T_1), fortification with FAO recommended vitamin and mineral mixtures (T_2), fortification with carrot powder (T_3), fortification with pumpkin powder (T_4) and fortification with carrot + pumpkin powder (T_5) with three replications. All the analysis was performed using HPLC and UV-Vis Spectrophotometer. Results revealed that the level of vitamin C and ß-carotene was increased after fortification into chips as compared to the control. Likely the processing loss of vitamin C and ß-carotene was also recorded as 17-36 % and 2-40 % during fortification. Thenafter, the fortification process increased the vitamin C and ß-carotene more 5.81-7.49 % and 5.04-25.54 % than the control sample.

Introduction

Food fortification is defined as the practice of adding vitamins and minerals to commonly consumed foods during processing to increase their nutritional value. It is a proven, safe, and cost-effective strategy for improving diets and for the prevention and control of micronutrient deficiencies. The nutrient deficiencies are occurred due to several processes of food by thermal and non-thermal treatment, light intensity, and longtime storage. The deficiencies of nutrients could be preserved by the fortification process. No attempt has been taken in the country to quantify and improve the nutrient by fortification process. Hence, the study has undertaken to fortify the lentil chips using native resources like carrot and pumpkin powder instead of FAO recommended vitamin and mineral premixes.

Materials and Method

Materials: BARI Mosur 8.

Treatments

T_1= chips without fortification (control); T_2= fortification with FAO recommended vitamin and mineral mixture; T_3= fortification with carrot powder; T_4= fortification with pumpkin powder; T_5= fortification with carrot and pumpkin powder

Fortification process of the developed lentil chips

The chips were fortified according to the above treatments and following the Fig.1.

Sensory evaluation: Sensory evaluation based on a 9-point hedonic scale and according to the method described by Joshi (2006) by forming a taste panel.

Statistical analysis: Data obtained for each analysis were expressed in duplicate as means (3 replications) ± standard deviation. Data was analyzed by One-way ANOVA with post-hoc using the Turkey Multiple Comparisons Test. The significance was defined at the 95 % confidence level. Statistical analysis and data processing were performed using the software SPSS 17.0 (IBM INC., New York).

Results and discussion

Vitamin C and ß-carotene of the fortified lentil chips

Vitamin C and ß-carotene of the fresh ingredients are shown in Table 1. The increases and loss of vitamin C and ß-carotene during processing into chips are shown in Table 2, Table 3, Table 4, and Table 5.

Vitamin C in fresh and fortified chips

The range of vitamin C in the fresh ingredients was recorded from 23.52 ± 0.08 to 47.06 ± 0.06 mg/100 g whereas its presence in the fortified chips with range of 5.61 ± 0.04 to 11.01 ± 0.04 mg/100 g respectively (Table 1 and Table 2). Results indicate that the vitamin C content of the treated chips was increased from 5.81 ± 0.00 to 7.49 ± 0.03 mg/100 g after fortification (Table 2). Likely the loss of vitamin C content was calculated from 17.91 ± 0.04 to 36.05 ± 0.02 mg/100 g due to several processing and heat processing during fortification. However, the daily requirement of 10 mg vitamin C to prevent scurvy for adults could be obtained by the daily consumption of 40-50 g lentil chips.

Table 1. Vitamin C and ß-carotene of fresh fortification ingredients

Ingredients	Vitamin C (mg/100 g)	ß-carotene (mg/100 g)
Spices & Condiments (control)	23.52 ± 0.08e	20.35 ± 0.35e
FAO vitamin and mineral mixture	29.41± 0.09d	41.33 ± 0.33d
Carrot powder	32.31 ± 0.10c	79.77 ± 0.23c
Pumpkin powder	35.29 ± 0.29b	80.58 ± 0.12b
Carrot and pumpkin powder	47.06 ± 0.06a	83.90 ± 0.10a

All values are means of triplicate determinations ± SD. Means within rows with different letters a, b, c, d, e indicate significant result ($p<0.05$).

Table 2. Vitamin C and increase of vitamin C content of the fortified chips

Treatment	Vitamin C of the fresh ingredients (mg/100 g)	Vitamin C of fortified chips (mg/100 g)	Vitamin C of control chips (mg/100 g)	Increase of vitamin C after fortification (mg/100 g)	Loss of vitamin C during processing (mg/100 g)
T_1	23.52 ± 0.08e	3.52 ± 0.07d		0.00 ± 0.00e	17.91 ± 0.04e
T_2	29.41± 0.09d	9.33 ± 0.07c		5.81 ± 0.00d	20.08 ± 0.02d
T_3	32.31 ± 0.10c	9.71 ± 0.11c	3.52± 0.07	6.19 ± 0.40c	22.60 ± 0.01c
T_4	35.29 ± 0.29b	10.13 ± 0.21b		6.61 ± 0.14b	35.42 ± 0.18b
T_5	47.06 ± 0.06a	11.01 ± 0.04a		7.49 ± 0.03a	36.05 ± 0.02a

All values are means of triplicate determinations ± SD. Means within rows with different letters a, b, c, d, e indicate significant result ($p<0.05$).

β-carotene into fresh and fortified chips: β-carotene is the main safe dietary source of vitamin A. It is essential for normal growth and development, immune system functioning and vision (Liji and Dibakar, 2015). Table 3 represents the ß-carotene content of the fresh ingredients and after fortification into chips. Results indicate that the highest ß-carotene was recorded in fortified chips with carrot and pumpkin powder. Likely, the loss of ß-carotene was also calculated in the fortified chips due to their several processing, light intensity and thermal processing during fortification.

Table 3. ß-carotene and increase of ß-carotene content of the fortified chips

Treatment	ß-carotene of the fresh ingredients (mg/100 g)	ß-carotene into fortified chips (mg/100 g)	ß-carotene of control sample (mg/100 g)	Increased ß-carotene after fortification (mg/100 g)	Loss of ß-carotene during processing (mg/100 g)
T_1	20.35 ± 0.35e	18.27 ± 0.30d		0.00 ± 0.00e	2.08 ± 0.05d
T_2	41.33 ± 0.33d	23.31 ± 0.21c		5.04 ± 0.28d	18.02 ± 0.12c
T_3	79.77 ± 0.23c	39.43 ± 0.13c	18.27 ± 0.03	21.16 ± 0.14c	40.34 ± 0.10b
T_4	80.58 ± 0.12b	40.43 ± 0.10b		22.16 ± 0.07b	40.15 ± 0.02b
T_5	83.90 ± 0.10a	43.81 ± 0.08a		25.54 ± 0.05a	40.09 ± 0.02a

All values are means of triplicate determinations ± SD. Means within rows with different letters a, b, c, d, e indicate significant result ($p<0.05$).

Conclusion

After fortification, the vitamin C and β-carotene of the chips were enriched than control. The loss of vitamin C and β-carotene was also noted during fortification process, but the loss of level was not higher than control chips.

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DESIGN AND FABRICATION OF SMART PACKAGES IN TERMS OF STORAGE AND MARKETING OF THE DEVELOPED LENTIL CHIPS

M.M.Molla, M.H.H.Khan, M.G.F. Chowdhury, S.Pervin, B.C.Dey, P.Sen, M.S.Zaman, P.Bhowmik and A.Khatun

Abstract

The study was conducted to develop 3D attractive smart package to marketable life and market study of the developed lentil chips. The packages has been developed with the technical assistance of the Quality Management System Certified Company " Phoenix" (ISO 9001:2015), Naya Paltan, Dhaka. The quantity of the chips in pouches were retained 15 g as net weight with three different colors. The developed packages were approved by the Bangladesh Standard and esting Institute (BSTI), Tejgaon, Dhaka for commercial marketing of the chips under the BDS code 1556. Then the lenti chips were poured into the developed smart package for marketable study of the chips. The marketable life of the chips could be extended upto 5 months by the smart packages.

Introduction

Intelligent packaging is an emerging technology that uses the communication function of the package to facilitate decision making in order to achieve the benefits of enhanced food quality and safety (Yam, 2012). Intelligent packaging is considered as 3D smart packaging technology. This technology that allows rapid prototyping through a 3D printer, adding layer-by-layer materials based on reconstructed models using computer codes (307). The World Economic Forum considers 3D printing as "the third and fourth industrial revolution". It has developed rapidly and has been applied in many industries, such as medicine, aerospace, automotive, food, art, textile, architecture, etc. Hence, the present study has undertaken to design and fabrication of a smart package to retain its crispiness, marketable life and enhance the marketing of the chips considering consumer choice.

Materials and methods

Materials: Double-layer opaque aluminum foil

Methods: The Quality Management System Certified Company " Phoenix" (ISO 9001:2015), Naya Paltan, Dhaka assisted to develop 3D attractive smart packages with net weight 15 g with three different colors.

Results and discussion

Smart packages, Manufacturer, Packer, and Marketer of the chips: The South Asian Agro Products (brand: RESCO), Naga, holding Number-288, block-A, ward number-19, Gazipur Saday, Gazipur has shown their interest in marketing of the chips. According to BSTI rules, the manufacturer name with their detailed inflrmation has been printed in the smart packages (Fig.1) with its nutrition facts. Three types of packages were developed with three different colors for lentil, black gram and mung bean (Fig.1).

Fig.1. Smart packages with three colors

BSTI approval: The BSTI has been approved the smart packages as RESCO 'Chips Dal' under the BDS code 1556 with nutrition facts and detailed information of the manufacturer.

Storage/marketable life studies of the chips: From the commercial aspect, the chips were packed with nitrogen flash. Each packet contains 15 g of chips during packing. Then the packed chips were stored at ambient conditions to record their marketable life. The marketable life of the chips was monitored at 15 days of intervals until the chips loss of their crispiness due to the leaching of nitrogen and mechanical error over the storage periods. No crispiness and odd flavor were recorded by the stored chips up to 5 months. The better crispiness and good appearances without deteriorating any quality is considered as maximum marketable life limit (Fig.2).

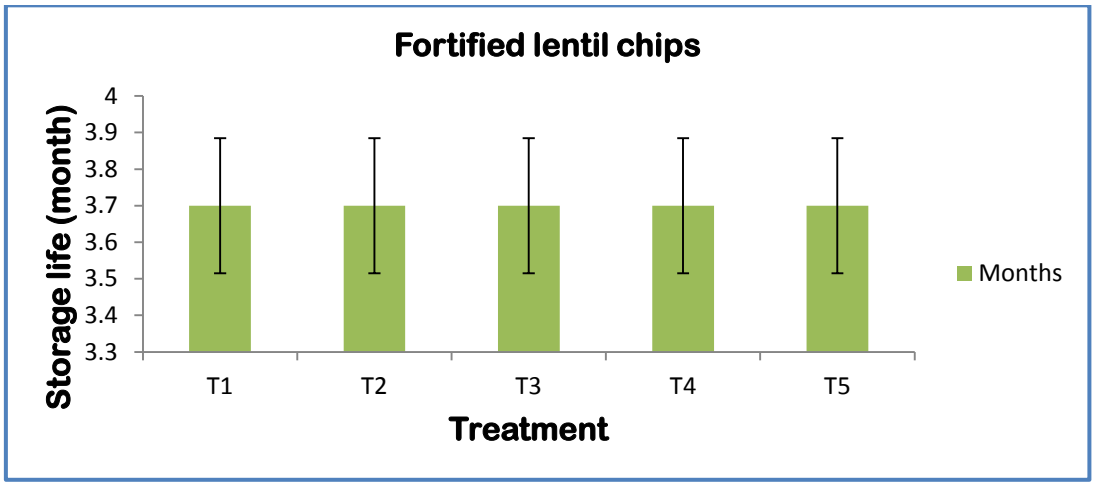

Fig.2. Marketable life of the control and fortified lentil chips over the storage periods

Consumers' perception by market study: The developed smart packages with chips have locally marketed at Krishi Sombay Market of BARI, Sromik Club Market and BARI high school and Anonda Shishu Kanon School by vendor. More than 300 consumers were highly satisfied to the chips and attractive smart packages.

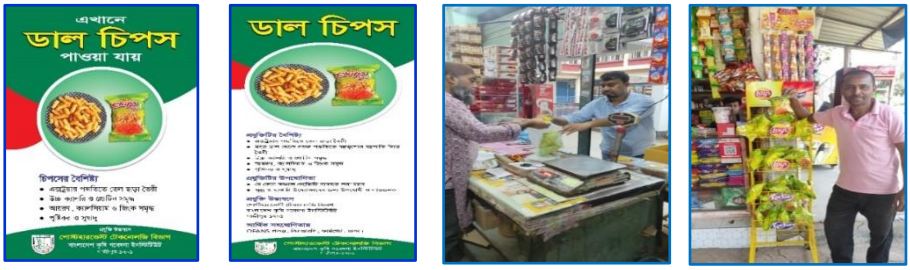

Fig.3. Demonstration and marketing to popularize the lentil chips

Conclusion

The smart package has been developed with the technical assistance of Quality Management System Certified Company " Phoenix" (ISO 9001:2015), Naya Paltan, Dhaka with a net weight of 15 g and three attractive colors. The smart package of the chips was approved by the BSTI under the BDS code 1556.

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EFFECT OF BLANCHING ON THE QUALITY AND SHELF LIFE OF BARI PANIKOCHU

S. PERVIN, M.H.H KHAN, M.G.F. CHOWDHURY AND M.M. MOLLA

Abstract

This study examined the effects of blanching and storage on the quality and shelf life of two panikochu (*Colocasia esculenta*) varieties, BARI Panikochu-4 and BARI Panikochu-5. Blanching times of 0, 1, 2, and 3 minutes were used to determine their impact on antioxidant, energy, and phenolic content during six months of storage. Results showed that extended blanching (3 minutes) significantly improved antioxidant, energy, and phenolic retention in both varieties. BARI Panikochu-5 blanched for 3 minutes demonstrated the highest antioxidant and energy values, while BARI Panikochu-4 blanched for 3 minutes had the highest phenolic content. These findings suggest that blanching time and variety play crucial roles in maximizing nutrient retention and extending shelf life.

Introduction

Panikochu (*Colocasia esculenta*) is an important tropical root crop, widely grown and consumed in Bangladesh for its rich nutritional content and culinary applications. Despite its popularity, fresh panikochu are highly perishable, creating challenges in terms of storage and distribution. Panikochu is a starchy vegetable with a mildly sweet flavor and a potato-like texture. Its high fiber content and essential nutrients offer various health benefits, such as improved blood sugar regulation and enhanced gut and cardiovascular health. Blanching, a vital pre-freezing step, is employed to deactivate endogenous enzymes in vegetables, which helps preserve their quality during storage. However, the intensity of blanching must be carefully regulated to maintain the vegetable's color, texture, flavor, and nutritional value. Factors that contribute to vitamin C loss during blanching include the heat applied, blanching duration, cooking method, water volume, and the presence of metals (John, 1990). Freezing is a widely used preservation method as it inhibits the growth of bacteria, molds, and yeasts, ensuring prolonged freshness. Maintaining a constant storage temperature is crucial for retaining the quality of frozen fruits and vegetables. The present study aims to assess the physicochemical properties of frozen panikochu and to examine the shelf life of blanched panikochu during extended storage.

Materials and Methods

Fresh Panikachu of the varieties BARI Panikachu 4 and 5 were obtained from local farmers and prepared through sorting, grading, washing, and cutting. The cut panikochu were soaked in a potassium metabisulfite (KMS) solution (1g/L) for 10 minutes. Blanching was performed using both water and steam for durations of 0, 1, 2, and 3 minutes, followed by immediate cooling. The treated panikochu were packed in high-density polyethylene bags and stored in a deep freezer. The physicochemical characteristics of the blanched panikochu were analyzed at two-month intervals over a six-month period. There were eight treatment groups as T_1 = Bari Panikochu-4 (Control); T_2 = Bari Panikochu-5 (Control); T_3 = Bari Panikochu-4 blanching for 1 min; T_4 = Bari Panikochu-5 blanching for 1 min; T_5 = Bari Panikochu-4 blanching for 2 min; T_6 = Bari Panikochu-5 blanching for 2 min; T_7 = Bari Panikochu-4 blanching for 3 min; T_8 = Bari Panikochu-5 blanching for 3 min. The total antioxidant activity was examined based on the DPPH free radical scavenging activity and the method adopted by Kamal *et al.* (2019). Total phenolic content was determined by the Folin-Ciocalteu method following the procedure of Kamal *et al.* (2019) with slight modification. The energy value (Kcal/100 g) was measured using standard methods. The experiment was designed as a completely randomized design (CRD) with factorial arrangements, and statistical analysis was performed using R software.

Results and Discussion

BARI Panikochu-4 (k_1) consistently showed higher antioxidant content than BARI Panikochu-5 (k_2) across storage periods due to genetic variation (Table 1). Antioxidant levels increased with longer blanching times, with 3 minutes (t_3) yielding the highest values at all stages, as it reduced enzymatic degradation. However, the interaction effect revealed that BARI Panikochu-5 with 3 minutes of blanching (T_8) retained the highest antioxidant content throughout storage, emphasizing that the right combination of variety and blanching time is crucial for optimal antioxidant retention.

BARI Panikochu-5 (k_2) had higher energy content than BARI Panikochu-4 (k_1) during storage, likely due to differences in carbohydrate composition. Energy content increased with longer blanching, peaking at 3 minutes (t_3), possibly due to moisture reduction concentrating energy.

Table 1. Effect on antioxidant (%) content in blanched panikochu varieties during storage

Treatments	Antioxidant (%) content of blanched panikochu during storage (month)			
	0	2	4	6
$T_1 = k_1 \times t_0$	35.12g	31.85f	28.32f	27.23f
$T_2 = k_2 \times t_0$	41.75e	33.86e	31.92c	30.74c
$T_3 = k_1 \times t_1$	43.25c	35.36c	33.68b	31.15b
$T_4 = k_2 \times t_1$	46.45a	38.56a	33.75a	31.75a
$T_5 = k_1 \times t_2$	33.23h	27.16h	26.89h	25.67g
$T_6 = k_2 \times t_2$	37.71f	29.82g	27.85g	25.54h
$T_7 = k_1 \times t_3$	42.23d	34.34d	29.76e	27.56e
$T_8 = k_2 \times t_3$	45.18b	37.29b	30.84d	29.12d
CV (%)	0.071	0.073	0.081	0.086
$LSD_{0.1\%}$	0.051***	0.043***	0.043***	0.043***

Note: All means followed by different letters relating to same parameter are statistically different up to 0.1% level of significance using the LSD.

The combination of BARI Panikochu-5 and 3 minutes of blanching (T_8) resulted in the highest energy content, preserving energy-rich compounds effectively. In contrast, BARI Panikochu-4 (k_1) had higher phenolic content than BARI Panikochu-5 (k_2), linked to genetic differences. Phenolic content also increased with longer blanching, with 3 minutes (t_3) inactivating polyphenol oxidase, preserving phenols. The highest phenol content was found in BARI Panikochu-4 with 3 minutes of blanching (T_7), aligning with previous research by Kumer (2013) and Kamal et al. (2020). These findings emphasize the role of variety and blanching time in maintaining energy and phenol levels during storage.

Table 2. Effect on phenolic content (mg GAE/100 g) in blanched panikochu varieties during storage

Treatments	Phenolic content of blanched panikocku during storage (month)			
	0	2	4	6
$T_1 = k_1 \times t_0$	9.87e	7.04f	6.75c	5.97e
$T_2 = k_2 \times t_0$	10.64b	8.01c	6.79c	6.03d
$T_3 = k_1 \times t_1$	9.55f	6.86e	6.46d	6.13c
$T_4 = k_2 \times t_1$	10.47c	7.53f	7.13f	7.03f
$T_5 = k_1 \times t_2$	8.17g	6.62g	6.53e	6.05f
$T_6 = k_2 \times t_2$	10.13d	7.37d	7.15e	5.93f
$T_7 = k_1 \times t_3$	7.83a	6.37a	6.22a	5.97a
$T_8 = k_2 \times t_3$	9.69b	7.19b	7.07b	5.76b
CV (%)	0.244	0.312	0.406	0.381
$LSD_{0.1\%}$	0.043***	0.043***	0.051***	0.043***

Note: All means followed by different letters relating to same parameter are statistically different up to 0.1% level of significance using the LSD.

Conclusion

Blanching significantly influences the antioxidant, energy, and phenolic content of taro during storage. BARI Panikochu-5 blanched for 3 minutes retained the highest energy and antioxidant content, while BARI Panikochu-4 had the highest phenolic content. Longer blanching times are recommended for enhanced quality and shelf life.

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KINETICS OF DRYING AND REHYDRATION ON GREEN PEAS USING CABINET DRYER

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Abstract

This study evaluates the drying and rehydration kinetics of green peas using a cabinet dryer at three different temperatures (48°C, 58°C, and 68°C). Fresh green peas were either blanched or unblanched before drying, and the experiment followed a completely randomized design (CRD). The moisture ratio (MR) and rehydration properties were analyzed. Results indicated that higher temperatures led to quicker drying rates, with blanched peas demonstrating superior rehydration ratios. The highest rehydration ratio (2.36) was observed in blanched peas dried at 48°C (T_2), while the highest coefficient of reconstitution (10.90) occurred in blanched peas dried at 58°C (T_4). The findings suggest that blanching significantly improves the rehydration properties of dried green peas, making it a vital step in the dehydration process.

Introduction

Green peas (*Pisum sativum*), a leguminous vegetable, have long been a staple in human diets due to their rich nutritional profile. They are a valuable source of protein, vitamins, and minerals, while being low in fat, high in fiber, and free from cholesterol. However, fresh green peas, containing approximately 78% moisture, are highly perishable. To extend their shelf life, various preservation techniques, including drying, canning, freezing, and cold storage, are commonly employed (Doymaz and Kocayigit, 2011). Among these methods, drying is increasingly popular as it enhances shelf life, improves handling and transportation, and preserves palatability (Jadhav et al., 2010). The study of rehydration kinetics for dried food products has been explored in previous research (Madamba and Liboon, 2011). In this context, the present study aims to evaluate traditional methods for processing green peas, investigate their drying kinetics, and identify optimal drying parameters for efficiency. Additionally, the study assesses the rehydration characteristics of the dried green peas.

Materials and Methods

Fresh green peas were sourced directly from local farmers and underwent sorting, washing, and cleaning. Following this, water blanching was performed and immediately followed by cooling. The peas were then dried using a cabinet dryer. Once dried, the peas were packed in high-density polyethylene (HDPE) bags and stored at ambient temperature for a duration of 12 months. The drying and rehydration characteristics of the peas were calculated using standard equations and subsequently analyzed recorded data. The experiment involved six treatment groups: T_1=unblanched green peas dried at 48°C, T_2=blanched green peas dried at 48°C, T_3=unblanched green peas dried at 58°C, T_4=blanched green peas dried at 58°C, T_5=unblanched green peas dried at 68°C, and T_6=blanched green peas dried at 68°C. The study was structured using a completely randomized design (CRD) and statistical analyses were conducted with R software.

Results and Discussion

The green pea seeds were dried in a Memmert dryer at three different temperatures (48°C, 58°C and 68°C) with single layer of material. The experimental data were analyzed and the moisture ratio (MR) versus drying time (hr) was plotted on a semi-log co-ordinate and regression lines were drawn. The following regression equations have been developed:

$MR = 1.2509e^{-0.118t}$ (For 48^0C unbalanced green pea, t=h) ---------- (1)

$MR = 1.1434e^{-0.124t}$ (For 48^0C balanced green pea, t=h) ---------- (2)

$MR = 1.0991e^{-0.136t}$ (For 58^0C unbalanced green pea, t=h) ---------- (3)

$MR = 1.066e^{-0.151t}$ (For 58^0C balanced green pea, t=h) ---------- (4)

$MR = 0.9571e^{-0.153t}$ (For 68^0C unbalanced green pea, t=h) ---------- (5)

$MR = 0.8536e^{-0.169t}$ (For 68^0C balanced green pea, t=h) ---------- (6)

From Fig. 1 and also from equations 1 to 6 above, it was seen that the moisture ratio (MR) decreased with time and the time to dry at a specific moisture ratio decreased with increasing temperature. At very high temperature and low humidity drying rate may initially increase, but the resulting case hardening would reduce the drying rate significantly and the product quality would be degraded by boiling instead of drying. The green pea dried very quickly at a temperature of 68 ^{0}C compared to that of 48 ^{0}C and 58 ^{0}C treated peas. In addition, the drying time was significantly

reduced at elevated temperature, which resulted in a significant expansion of the drying capacity (Akoy, 2014).

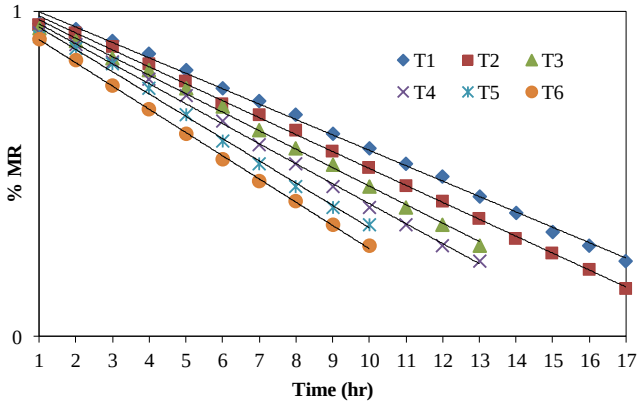

Figure 1. Effect of various temperature and blanching strategies on the drying rate of green pea

For dehydrated green peas, the rehydration ratio of blanched peas was higher than that of unblanched peas across all treated samples. Among the blanched peas, the highest rehydration ratio was observed in treatment T_2, with a value of 2.36, followed by treatments T_4 and T_6, both with a rehydration ratio of 2.29. This clearly indicates that blanching had a significant effect on the rehydration capacity of green peas. Regarding the coefficient of reconstitution, the blanched peas treated at 58°C in treatment T_4 showed the highest value of 10.90, while the lowest value of 7.93 was recorded for the unblanched peas treated at the same temperature (T_1). This suggests that blanched peas possess better reconstitution properties compared to unblanched peas (Table 1).

Table 1 Effect of various temperature and blanching strategies on the rehydration characteristics of dehydrated green pea

Treatments	Sample taken (g)	Weight (g) of the rehydrated sample after 30 min	Rehydration ratio (RR) for 30 min	Dehydration ratio (DR)	Co-efficient of reconstitution =(RR/DR)
T_1	5	11.69	2.14	0.27	7.93
T_2	5	11.78	2.36	0.26	9.08
T_3	5	11.13	2.10	0.22	9.55
T_4	5	11.91	2.29	0.21	10.90
T_5	5	11.44	2.13	0.26	8.19
T_6	5	11.76	2.29	0.25	9.16

Conclusion

Blanching significantly improves the rehydration and reconstitution properties of dried green peas. Peas blanched and dried at higher temperatures, particularly at 58°C, showed superior rehydration capacity compared to unblanched samples. This study emphasizes the importance of blanching and appropriate drying temperatures for producing high-quality, dehydrated green peas with better shelf life and rehydration characteristics.

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STANDARDIZATION OF OSMOTIC DEHYDRATION PROCESS FOR TODDY PALM

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Abstract

This study focused on optimizing the osmotic dehydration process for toddy palm to enhance its physicochemical qualities and extend shelf life. Six treatments with varying sugar concentrations (0%–25%) were applied. The texture, energy content, and overall acceptability were evaluated over a six-month storage period. Results showed that the higher sugar concentrations improved texture firmness and energy content, with the 25% sugar treatment (T_6) exhibiting the best performance. However, overall acceptability decreased over time, particularly in samples with lower sugar concentrations. Osmotic dehydration offers a viable method for preserving toddy palm's quality and nutritional value.

Introduction

The toddy palm (*Borassus flabellifer*) is a highly valued fruit, renowned for its medicinal and nutritional properties. Referred to as the "Wishing Tree" due to its ability to produce a wide range of economically significant products, the palm holds considerable potential for value addition. Despite this, processed toddy palm products remain scarce in the market, representing an untapped opportunity for diversification. Osmotic dehydration, a promising preservation method particularly suited for small-scale processing, can extend the shelf life of seasonal toddy palm products while maintaining their quality. This study aims to optimize the osmotic dehydration process for toddy palm, with a focus on preserving its physicochemical qualities. By doing so, it seeks to minimize post-harvest losses, increase availability, and meet consumer demand throughout the year. Toddy palm's young fruit kernel, haustorium, and boiled tuber are rich in essential nutrients, total phenolic content, and vitamin C, exhibiting antioxidant properties (Theivendrarajah *et al.*, 2008). Preserving these components through osmotic dehydration will not only enhance the shelf life of toddy palm products but also help consumers maintain their dietary requirements, thereby promoting overall health.

Materials and Methods

Toddy palm (*Borassus flabellifer*) were collected from the farmer's field. Fruits were sort, wash and clean. After preparation of osmoed palm by osmotic dehydration method and kept into glass jar. All packaged products were properly labeled and stored at ambient temperature (25-35°C). The physicochemical properties of all products were analyzed at intervals of two months after storage for 6 months. There were six treatments for making osmoed palm, as T_1 = 0% sugar with palm; T_2 = 5% sugar with palm; T_3 = 10% sugar with palm; T_4 = 15% sugar with palm; T_5 = 20% sugar with palm; and T_6 = 25% sugar with palm. The texture ($kg\text{-}f/cm^2$), energy (Kcal/100 g) and overall acceptability of stored palm were analyzed by standard methods. All treatments were repeated thrice and the research was done using CRD with analysis statistical software from R.

Results and Discussion

The texture of osmo-dehydrated toddy palm samples (expressed in $Kg\text{-}f/cm^2$) was observed to increase across all treatments over the storage period from 0 to 6 months (Table 1). The sample treated with 25% sugar (T_6) exhibited the highest texture value (8.97 $kg\text{-}f/cm^2$) at the end of the storage period, while the sample with 0% sugar (T_1) had the lowest (6.17 $kg\text{-}f/cm^2$). The increase in texture firmness is likely due to sugar's role in enhancing the structural integrity of the palm during dehydration, as well as moisture loss during storage.

In Table 2 expressed that the energy content of the osmo-dehydrated toddy palm also increased slightly during storage, with the highest values recorded in the sample treated with 25% sugar (T_6), which reached 5.93 Kcal/100 g by the end of the storage period. The lowest energy content was observed in the 0% sugar treatment (T_1), which reached 4.07 Kcal/100 g. The variation in energy content is primarily due to the higher sugar concentrations, which contribute more calories and possibly reduce moisture content, concentrating the energy values.

Overall acceptability decreased over the storage period for all treatments. The highest initial acceptability was recorded for the 15% and 20% sugar treatments (T_4 and T_5), both starting at 8.50 (i.e., like very much) but decreased to 7.50 (i.e., like moderately) by the end of the storage period shown in Table 3. The lowest acceptability was noted in the 0% sugar treatment (T_1), which started at 4.00 and remained low throughout storage. The decline in acceptability is likely due to changes in texture

and flavor as the storage time increases, which may lead to a less desirable product and the investigation is aligned with a study by Ullah *et al.* (2018).

Table 1. Effect on texture (kg-f/cm^2) of osmo-dehydrated toddy palm during storage

Treatments	Texture of osmo-dehydrated toddy palm during storage			
	0	2	4	6
T_1 = 0% sugar with palm	5.87e	6.02e	6.13e	6.17e
T_2 = 5% sugar with palm	6.27d	6.59d	6.75d	6.79d
T_3 = 10% sugar with palm	6.83c	7.05c	7.45c	7.57c
T_4 = 15% sugar with palm	7.19b	7.44b	7.75b	7.84b
T_5 = 20% sugar with palm	8.27a	8.43a	8.84a	8.92a
T_6 = 25% sugar with palm	8.43a	8.66a	8.82a	8.97a
CV (%)	1.766	1.838	1.655	1.508
$LSD_{0.1\%}$	0.224***	0.241***	0.224***	0.207***

Note: All means followed by different letters relating to same parameter are statistically different up to 0.1% level of significance using the LSD.

Table 2. Effect on energy (Kcal/100 g) of osmo-dehydrated toddy palm during storage

Treatments	Energy of osmo-dehydrated toddy palm during storage			
	0	2	4	6
T_1 = 0% sugar with palm	3.85d	3.93c	3.97c	4.07d
T_2 = 5% sugar with palm	5.05c	5.25b	5.29b	5.43c
T_3 = 10% sugar with palm	5.17c	5.35b	5.47b	5.62bc
T_4 = 15% sugar with palm	5.24bc	5.64a	5.69a	5.76ab
T_5 = 20% sugar with palm	5.46ab	5.75a	5.75a	5.84ab
T_6 = 25% sugar with palm	5.64a	5.81a	5.87a	5.93a
CV (%)	2.489	2.198	2.027	2.356
$LSD_{0.1\%}$	0.224***	0.207***	0.193***	0.228***

Note: All means followed by different letters relating to same parameter are statistically different up to 0.1% level of significance using the LSD.

Table 3. Effect on overall acceptability of osmo-dehydrated toddy palm during storage

Treatments	Overall acceptability of osmo-dehydrated toddy palm during storage			
	0	2	4	6
T_1 = 0% sugar with palm	4.00e	3.00d	3.00f	3.00e
T_2 = 5% sugar with palm	6.00d	6.00c	5.50e	5.00d
T_3 = 10% sugar with palm	6.50c	6.00c	6.00d	5.50c
T_4 = 15% sugar with palm	8.50a	8.00a	7.50b	7.50a
T_5 = 20% sugar with palm	8.50a	8.00a	8.00a	7.50a
T_6 = 25% sugar with palm	8.00b	7.00b	7.00c	7.00b
CV (%)	1.824	2.024	1.755	2.167
$LSD_{0.1\%}$	0.224***	0.228***	0.193***	0.228***

Note: All means followed by different letters relating to same parameter are statistically different up to 0.1% level of significance using the LSD.

Conclusion

The 25% sugar treatment (T_6) resulted in the highest firmness and energy content, but overall acceptability declined over time in all treatments. Osmotic dehydration proved effective in extending the shelf life of toddy palm while maintaining its physicochemical properties, making it a promising method for small-scale processing and value-added product development.

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STANDARDIZATION OF PROCESSING METHOD FOR GREEN COCONUT WATER JELLY

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Abstract

This study aimed to standardize the processing method for green coconut water jelly and assess its nutritional quality and storage stability. Green coconut water jelly was prepared using six different formulations, with varying amounts of sugar and citric acid. The physicochemical properties, including total soluble solids (TSS), phenolic content, and overall acceptability, were evaluated over 15 days of refrigerated storage. Treatments with higher sugar content (T_3, T_6) maintained higher TSS, while citric acid-containing treatments (T_4, T_5, T_6) retained more phenolic content. The overall acceptability of the jelly decreased during storage, with sugar and citric acid contributing to better sensory properties. These findings highlight the importance of sugar and citric acid in maintaining jelly quality during storage.

Introduction

Coconut (*Cocos nucifera* L.) is a vital commercial crop in tropical regions, often referred to as the "tree of heaven" or "tree of abundance." It is a versatile crop with uses ranging from foods to cosmetics (Prasad *et al.*, 2011). Coconut water jelly is a product made by boiling coconut water with sugar, pectin, and acid to create a gelatinous consistency containing fruit pieces suspended in the jelly. Standardizing the production methods for green coconut water jelly is essential for ensuring consistent quality and consumer satisfaction. Currently, the lack of uniform processing methods results in variations in taste, texture, and overall quality. Developing a standardized procedure would not only enhance product consistency but also reduce waste and add value to the coconut industry. Additionally, assessing quality changes during storage is critical for determining the product's shelf life and its ability to retain desirable characteristics over time. The aims of this study were to standardize processing method for green coconut water jelly and to evaluate its nutritional quality and storage life.

Materials and Methods

Green coconuts were collected from local farmers. The coconut water jelly was prepared and stored in glass and plastic jars under refrigeration. Physicochemical properties of the jelly were analyzed every 3 days over a 15-day period. Six treatments were used: T_1=1000 ml coconut water+1 g KMS+20 g agar-agar; T_2=1000 ml coconut water+1 g KMS+20 g agar-agar+20 g sugar; T_3=1000 ml coconut water+1 g KMS+20 g agar-agar+40 g sugar; T_4=1000 ml coconut water+1 g KMS+20 g agar-agar+4 g citric acid; T_5=1000 ml coconut water+1 g KMS+20 g agar-agar+20 g sugar+4 g citric acid; and T_6=1000 ml coconut water+1 g KMS+20 g agar-agar+40 g sugar+4 g citric acid. Total soluble solids (TSS), phenolic content, and overall acceptability of the jelly were analyzed using standard methods. The experiment followed a completely randomized design (CRD), with statistical analysis performed using R software.

Results and Discussion

The TSS content of green coconut water jelly showed a consistent decrease during the 15-day storage period across all treatments (Table 1). The highest initial TSS was observed in T_6 (16.80%), which gradually reduced to 14.80% by day 15. Conversely, the lowest initial TSS was in T_1 (8.90%), which decreased to 7.50% by day 15. Treatments with higher sugar content (T_3 and T_6) maintained higher TSS levels throughout storage compared to those without sugar or with lower sugar content. The TSS content declined due to microbial activity and chemical changes, including the breakdown of sugars during storage and similar study was carried out by Hai *et al.*, 2014 for longan fruits. Higher sugar concentrations in treatments like T_3 and T_6 helped in retaining more TSS during the storage period.

Phenolic content decreased across all treatments over the 15 days (Table 2). The highest phenol content was in T_6 (7.18 mg GAE/100 g), which decreased to 4.13 mg GAE/100 g by day 15. The lowest initial phenol content was in T_1 (5.07 mg GAE/100 g), reducing to 3.08 mg GAE/100 g. Treatments with citric acid (T_4, T_5, T_6) had relatively higher phenol content throughout storage. The reduction in phenol content is likely due to oxidative processes during storage, which degrade phenolic compounds. This investigation has consistent with findings by Kamal *et al.*, 2020. Citric acid may help in retaining phenol content due to its antioxidant properties, reducing the rate of phenol degradation.

Table 1. Effect on TSS (%) content of processed green coconut water jelly during storage

Treatments	TSS (%) content of processed green coconut water jelly during storage (days)					
	0	3	6	9	12	15
T_1	8.90d	8.50d	8.10d	7.80e	7.70d	7.50e
T_2	12.20c	11.70c	11.30c	10.90d	10.70c	10.30d
T_3	16.30b	15.50b	15.20b	14.80b	14.60b	14.30b
T_4	8.80d	8.40d	8.10d	7.90e	7.70d	7.60e
T_5	12.40c	11.80c	11.40c	11.20c	10.80c	10.70c
T_6	16.80a	16.30a	15.90a	15.60a	15.20a	14.80a
CV (%)	1.020	0.956	1.081	1.191	1.135	1.070
$LSD_{0.1\%}$	0.228***	0.205***	0.224***	0.241***	0.224***	0.207***

Note: T_1=1000 ml coconut water+1 g KMS+20 g agar-agar; T_2=1000 ml coconut water+1 g KMS+20 g agar-agar+20 g sugar; T_3=1000 ml coconut water+1 g KMS+20 g agar-agar+40 g sugar; T_4=1000 ml coconut water+1 g KMS+20 g agar-agar+4 g citric acid; T_5=1000 ml coconut water+1 g KMS+20 g agar-agar+20 g sugar+4 g citric acid; and T_6=1000 ml coconut water+1 g KMS+20 g agar-agar+40 g sugar+4 g citric acid. All means followed by different letters relating to same parameter are statistically different up to 0.1% level of significance using the LSD. All means followed by different letters relating to same parameter are statistically different up to 0.1% level of significance using the LSD.

Table 2. Effect on phenolic (mg GAE/100 g) content of processed green coconut water jelly during storage

Treatments	Phenolic content of processed green coconut water jelly during storage (days)					
	0	3	6	9	12	15
T_1	5.07c	4.57c	3.46e	3.17e	3.12e	3.08d
T_2	5.26c	4.66c	3.67d	3.34de	2.27f	2.14e
T_3	6.98a	6.18a	5.42a	5.28a	5.17a	5.14a
T_4	5.18c	4.68c	3.64de	3.45d	3.38d	3.35c
T_5	6.13b	5.53b	3.89c	3.75c	3.67c	3.56c
T_6	7.18a	6.38a	4.47b	4.29b	4.17b	4.13b
CV (%)	2.114	2.180	2.645	3.304	3.476	3.796
$LSD_{0.1\%}$	0.224***	0.207***	0.193***	0.228***	0.224***	0.241***

Note: All means followed by different letters relating to same parameter are statistically different up to 0.1% level of significance using the LSD.

Overall acceptability declined across all treatments during storage. T_2 and T_5 (with 20 g sugar) had higher acceptability scores (8.0) initially, dropping moderately to 6.5 by day 15. Treatments with less or no sugar (T_1, T_4) showed a greater decline. The decrease in acceptability was likely due to changes in texture, flavor, and appearance caused by ingredient breakdown and possible microbial growth. These findings are consistent with Ullah et al. (2018), indicating that sugar and citric acid enhance sensory properties and help maintain acceptability.

Conclusion

The study successfully standardized a processing method for green coconut water jelly. Formulations with higher sugar and citric acid showed better preservation of TSS, phenolic content, and sensory acceptability over a 15-day storage period, indicating their importance in maintaining product quality.

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STANDARDIZATION OF PROCESSING METHOD FOR OSMO DEHYDRATED SUGAR COATED PLUM

S. PERVIN, M.H.H. KHAN, M. M. MOLLA AND M.G.F. CHOWDHURY

Abstract

The study aimed to standardize the processing method for osmo-dehydrated sugar-coated plum to enhance its shelf life, overall quality and minimize postharvest losses. Plum fruits were treated with 40, 50, and 60°Brix sugar syrup and sugar coating. Texture analysis revealed a decrease in firmness during storage due to cell structure breakdown and enzymatic activity. Color intensity decreased significantly over 12 months of storage, while total phenolic content declined with increasing brix and prolonged storage. Osmo-dehydrated plum exhibited excellent energy content. The highest overall rating was given to plum treated with 50 ^{0}Brix sugar syrup and sugar coating. In conclusion, osmotic dehydration with sugar coating is a viable method to enhance plum preservation and create a value-added product.

Introduction

Plum (*Prunus domestica*) is a valuable spice crop known for its antioxidant properties and mild laxatives (Miletic *et al.*, 2012). However, postharvest losses due to perishability are significant in Bangladesh. The release of the high-yielding variety "BARI Alu bukhara-1" offers potential to enhance plum production. Osmotic dehydration, a promising preservation method, improves quality and reduces drying time (Birwal *et al.,* 2016). This research aims to optimize dehydration conditions using locally available machinery and low-level technology for cost-effective processing and long-term preservation. Osmotic dehydration allows diversification of plum products, meeting the demand for dried prunes domestically and internationally. The study aims to enhance plum utilization, minimize losses, and extend shelf life through value-added product development. The present study standardizes and produces high-quality osmo-dehydrated plum products.

Materials and Methods

Plum (*Prunus domestica*) with optimal ripeness was collected from local farmer. Fruits were sorted, washed and cleaned. Then, the fruits were dipped in 40, 50 and 60 ^{0}Brix sugar syrup for 24 h and then it boils for 15 min. The drying temperature was maintained at 60 ^{0}C. After drying, the plum was preserved in a glass container. Finally, the treated plums were analyzed after 3 months' interval up to 1 year in an ambient condition. There were six treatments to prepare sugar coated osmo-dehydrated plum. These were: T_1= 40 ^{0}B in plum; T_2= 40 ^{0}B in plum with sugar coating; T_3= 50 ^{0}B in plum; T_4= 50 ^{0}B in plum with sugar coating; T_5= 60 ^{0}B in plum; and T_6= 60 ^{0}B in plum with sugar coating. The texture, color, total phenolic content, energy and overall acceptability of osmo-dehydrated stored plum were analyzed by standard methods. The study was conducted using CRD with each treatment replicated three times, and data analysis was performed using statistical software from R.

Results and Discussion

The texture of osmo-dehydrated plum decreased from an initial maximum of 166.47 N to 110.27 N in T_1 but it was 147.27 N to 89.74 N as lowest in T_5 at the end of storage, likely due to cell structure breakdown and enzymatic activity during storage, resulting in softer fruit texture. Similar findings were reported for osmo-dehydrated apricot by Sharma *et al.,* 2006. The color intensity of osmo-dehydrated plum, initially light yellow color significantly decreased to light dark after 12 months of storage. Treatments T_4 had the highest brightness, while T_1 had the lowest. The color of osmo-dehydrated plum decreased significantly during prolonged storage, as described by Goncalves *et al.* (2007). In osmo-dehydrated plum, total phenolic content ranged from 145.0 to 134.0 mg GAE/100 g at the beginning of storage, and after 180 days, it varied between 95.4 to 78.5 mg GAE/100 g from treatment T_1 to T_6, respectively (Table 1). Total phenolic content significantly decreased with increasing brix used as the osmotic agent and further decreased with the increase in storage period, consistent with findings by Kamal *et al.,* 2020. The calorific value (energy content) of the osmo-dehydrated plum was presented in Table 2. It is seen that all sample showed an excellent source of energy, which ranged from 99.68 to 70.13 Kcal/100 g at the beginning and 75.07 to 61.87 Kcal/100 g at the end of storage period. These values were found to differ significantly among the dehydrated plum prepared using different brix as well as extension of storage period. The highest overall rating (7.5) was given by panelists to osmo-dehydrated plum from treatments T_4 (50^{0}B in plum with sugar coating), indicating like moderate to like very much but lowest rating (5.0) was in treatment T_1 after

12 months of storage. However, sensory values of osmo-dried plum showed a decrease rate during storage.

Table 1. Effect of brix and sugar coating on total phenol (mg GAE/100 g) of osmo-dehydrated plum during storage

Treatments	Total phenol (mg GAE/100 g) of osmo-dehydrated plum with different storage (Month)				
	0	3	6	9	12
T_1= 40 ^{0}B in plum	145.0a	119.2a	113.8a	104.0a	95.4a
T_2= 40 ^{0}B in plum with sugar coating	143.5b	113.5b	101.7b	98.7b	94.2b
T_3= 50 ^{0}B in plum	140.0c	110.3c	102.5c	93.2c	87.5c
T_4= 50 ^{0}B in plum with sugar coating	138.5d	102.1d	99.7d	91.5d	85.0d
T_5= 60 ^{0}B in plum	135.0e	93.5e	88.6e	83.2e	80.6e
T_6= 60 ^{0}B in plum with sugar coating	134.0f	92.3f	87.1f	82.4f	78.5f
CV (%)	0.162	0.138	0.124	0.110	0.096
$LSD_{1.0\%}$	0.391	0.251	0.213	0.176	0.144

Table 2. Effect of brix and sugar coating on energy (Kcal/100 g) of osmo-dehydrated plum during storage

Treatments	Energy (Kcal/100 g) of osmo-dehydrated plum with different storage (Month)				
	0	3	6	9	12
T_1= 40 ^{0}B in plum	70.13f	64.93e	63.12e	62.93e	61.87f
T_2= 40 ^{0}B in plum with sugar coating	70.65e	65.12e	64.56d	63.94d	62.75e
T_3= 50 ^{0}B in plum	86.64d	76.95d	75.48c	74.34c	72.87d
T_4= 50 ^{0}B in plum with sugar coating	88.45c	77.81c	75.94b	74.58c	73.94c
T_5= 60 ^{0}B in plum	95.47b	78.92b	77.84a	76.97b	74.49b
T_6= 60 ^{0}B in plum with sugar coating	99.68a	79.54a	78.08a	77.79a	75.07a
CV (%)	0.255	0.259	0.231	0.202	0.175
$LSD_{1.0\%}$	0.377	0.332	0.289	0.251	0.213

Conclusion

Osmotic dehydration with sugar coating at 50 ^{0}Brix showed the most promising results for preserving plum, enhancing overall quality and energy content. This technique presents an effective method for extending plum shelf life and creating value-added products for commercial use.

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OPTIMIZATION OF PROCESSING METHOD FOR DRAGON FRUIT JAM

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Abstract

This research aimed to optimize the processing method for dragon fruit jam and assess its quality parameters during long-term storage at ambient temperature in Bangladesh. Five treatments were employed, varying the sugar content in the dragon fruit pulp. The pH, acidity, TSS (%), color, microbial growth, and sensory evaluation were conducted over a storage period of six months. The results revealed that higher sugar content led to lower initial pH and higher acidity in the jam. TSS values were highest in treatment T_5 (100% sugar in pulp). Color intensity decreased during storage, and microbial growth remained within acceptable limits. Sensory evaluation indicated that jam with 80% sugar in pulp (T_4) received the highest overall rating. These findings offer valuable insights for optimizing dragon fruit jam processing for extended shelf life and consumer acceptance.

Introduction

Dragon fruit (*Hylocereus undatus*) is a tropical fruit that has become increasingly popular in recent years. Processed dragon fruit products are rarely available in our markets and very little work has been done on processing of dragon fruit in our country. A number of locally processed fruit products are now available in the market. If quality products from dragon fruit are developed, it might be welcomed by the consumers who have affinity for dragon fruit round the year. So the scope of utilizing dragon fruit remains bright in Bangladesh. Development of varieties of products like jam utilizing local produces is critically important for expanding the country's developing food industries. Jam is a homogeneous and molded product which is obtained by boiling fresh, frozen or semi-processed chemically canned fruits with added sugar, pectin and acid (Sandulachi, 2011). Therefore, the present study was carried out to optimize the processing method for dragon fruit jam and to evaluate its quality parameters for long time storage at ambient temperature.

Materials and Methods

Dragon fruits were collected from the Regional Agricultural Research Center, Chittagong. Fruits was sort, wash and clean. The major ingredients for the preparation of jam were sugar, citric acid, pectin and other chemicals were used from the laboratory store. The fully ripe healthy and fresh dragon fruit was washed thoroughly with potable water and the skin was removed by a knife. The seeds were removed and then dragon fruit was blended by a blending machine. The jam formulations were prepared by following the composition stated by Touati *et al.* (2014), which contains fruit pulp, sugar, pectin and citric acid. Pectin and citric acid were added as much as needed, following the rules by RDC (Technical Regulation of Good Practices for Food Services). There were five treatments for making jam, as T_1=20% sugar in dragon pulp; T_2=40% sugar in dragon pulp; T_3=60% sugar in dragon pulp; T_4=80% sugar in dragon pulp; and T_5=100% sugar in dragon pulp. In preparation, pectin was mixed with equal amount sugar in a stainless steel pot. The remaining sugar was mixed with dragon fruit pulp and heated; then, sugar mixed pectin was added and continued the heating; citric acid was added and continued the heating. When TSS of the jam becomes 65^0 brix, then the KMS was added and prepared dragon fruit jam kept into glass jar and required data were collected with two month interval for a period of 6 months. The pH, acidity (%), TSS (%), color, microbial growth and overall acceptability of stored dragon fruit jam were analyzed by standard methods. The study was conducted using CRD with each treatment replicated three times, and data analysis was performed using statistical software from R.

Results and Discussion

Initially the maximum pH of 3.92 was observed with treatment T_5 and at the end of six months it was 3.64 but the pH of 3.52 was lowest with treatment T_1 and finally it was 3.12. On the other hand, initially the maximum acidity of 0.91% was observed with treatment T_1 after six months it was 1.07% but the acidity of 0.71% was lowest with treatment T_5 and finally it was 0.92%. The pH of stored dragon fruit jam likely decreased and acidity increased due to natural fermentation processes, and these findings similar with that of Stella *et al.* (2011) in orange nectars. In Table 1, initially the maximum TSS of 61.42% was observed with treatment T_5 and at the end it was 64.90% but the TSS of 34.30% was lowest with treatment T_1 and finally it was 38.90%. A similar study was carried out by Hai *et al.*, 2014 for longan fruits. Initially, the jam color intensity was light red to red for the

treatments of T_1 to T_5, respectively but finally it has gradually decreased and changes to dark color after six months of storage. The highest brightness was observed with treatment T_1 and the lowest with treatment T_5, but the lightness values were decreased up to 6 months of storage. The microbial growth of the dragon fruit jam from various treatments was not observed for up to four months of storage. However, the microbial growth of the dragon fruit jam was observed in small numbers (13 to 21×10^{-1}); these were non-pathogenic bacteria and an acceptable limit for human consumption for various treatments (T_1 and T_2) after six months of storage at ambient condition. In Table 2, among the treatments, the panelists gave the highest overall rating 7 (i.e., like moderately) of jam made with 80% sugar in pulp with treatment T_4 followed by 100% sugar in pulp and rating 6 (i.e., like slightly) with treatment T_5. The decrease in sensory values during storage was also shown for ready-to-eat peanut chutney by Veerapandian *et al.* (2014).

Table 1. Effect of percent sugar on the TSS (%) of dragon fruit jam in storage

Treatments	TSS (%) of dragon fruit jam with different storage (Month)			
	0	2	4	6
T_1= 20% sugar in dragon pulp	34.30e	37.80a	38.60e	38.90e
T_2= 40% sugar in dragon pulp	42.10d	44.40b	45.60d	45.80d
T_3= 60% sugar in dragon pulp	52.30c	54.40c	55.20c	55.70c
T_4= 80% sugar in dragon pulp	56.10b	59.20d	60.30b	60.80b
T_5= 100% sugar in dragon pulp	61.42a	63.42e	64.30a	64.90a
CV (%)	0.626	0.595	0.584	0.579
$LSD_{1.0\%}$		0.561		

Table 2. Effect of percent sugar on overall acceptability of dragon fruit jam in storage

Treatments	Overall acceptability of dragon fruit jam with different storage (Month)			
	0	2	4	6
T_1= 20% sugar in dragon pulp	5.00c	4.50c	4.50d	4.50c
T_2= 40% sugar in dragon pulp	6.00b	5.50b	5.50bc	5.00c
T_3= 60% sugar in dragon pulp	6.00b	5.50b	5.00cd	5.00c
T_4= 80% sugar in dragon pulp	8.00a	7.00a	7.00a	7.00a
T_5= 100% sugar in dragon pulp	8.00a	6.00b	6.00b	6.00b
CV (%)	5.618	6.505	6.622	6.742
$LSD_{1.0\%}$		0.675		

The mean values in the columns are displayed in significant result ($p<0.01$) with various letters a, b, c and d.

Conclusion

This study successfully optimized the processing method for dragon fruit jam and examined its quality parameters during long-term storage. The research outcomes contribute to enhancing the production of high-quality dragon fruit jam with improved shelf life and consumer acceptance.

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EFFECTS OF DIFFERENT DRYING METHODS ON PHYSICOCHEMICAL AND FUNCTIONAL PROPERTIES OF BARI SWEET POTATO 17

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Abstract

The main objective of our study was to investigate the effects of various drying techniques on the physicochemical and functional characteristics of BARI sweet potato 17. Three distinct techniques of drying sweet potatoes (i.e., sun drying, cabinet, and freeze drying) were used, and the changes in food components were evaluated. As a consequence of drying applications, the initial moisture content of the fresh sample was found to be 67.22 %, whereas the moisture level of the dried sweet potatoes varied from 4.89 % to 7.78 %. Compared to other samples, sun-dried sweet potatoes had higher losses of nutritional content. Results revealed that in terms of color characteristics and nutritional parameters, freeze-dried sweet potatoes fared better than the other two techniques. Results also showed that water and oil absorption capacities (WAC/OAC) of freeze-dried samples were significantly ($p \leq 0.05$) higher than sun and cabinet drying. These functional properties are useful in structure interaction in food, especially in flavor retention, palatability improvement, and shelf-life extension, particularly in bakery products. Therefore, it could be concluded that freeze-drying techniques produced superior quality sweet potato flour with retaining color and nutrients than cabinet and sun drying.

Introduction

Sweet potato (*Ipomoea batatas* Lam) is a nutritious vegetable that belongs to the Convolvulaceae family. It is one of the world's most important food crops. More than 95 % of the sweet potato crop is grown in developing countries (Van, 2000). In South Asia, Bangladesh is the second leading producer of sweet potatoes accounting for 27 % of the total production (FAOSTAT, 2020). It is a rich source of protein, dietary fiber, ascorbic acid, β-Carotene, vitamins, minerals e.g., iron, zinc, calcium, magnesium, and other biologically active phytochemicals such as carotenoids, polyphenol, anthocyanin (Alam et al., 2016; Sun et al., 2019). There are many problems related to the storage and transportation of raw sweet potatoes due to their high perishability in our country. It can be processed into food products such as biscuits, bread, cakes, and noodles with longer shelf life and improved characteristics. It contributes to reducing food shortages in times of crisis (natural disasters or wars). It is cheaper than other crops as a carbohydrate source, yet this abundant resource is still not properly utilized.

Materials and Methods

Fresh sweet potatoes (variety: BARI sweet potato 17) were collected from the farmer's field in Sreepur, Gazipur. Then samples were sorted and graded. After that samples were washed with 1% calcium calcinate for 5 min and sliced. The sliced sweet potatoes were pretreated with 0.01 % KMS for 3 min. Finally, samples were dried at three different drying techniques with direct sunlight at 34-45 ^{0}C, a cabinet dryer at 55 ± 1 ^{0}C temperature, and a freeze dryer. The dried sweet potatoes were blended and packed into HDP polyethylene bags and then analyzed for different quality parameters. Moisture content, ash, vitamin C, and β-carotene were determined according to the method described by AOAC (2010). Anthocyanin was determined by the method of Molla et al., 2022. Total carotenoid content (TCC) was analyzed according to the method of Baria et al., 2019. The amount of total phenolic contents was calculated using the Folin Ciocalteu reagent according to the method described by Zeb and Rahman, 2024. The color parameters were assessed according to Medhe et al., 2019. The water and oil absorption capacities were determined by the standard method of Ayo et al., 2007.

Results and Discussion

The primary obstacle to processing fresh sweet potatoes is their moisture content. Dried sweet potatoes may be utilized as a potential alternative for highly perishable goods. The data regarding the physicochemical analysis of fresh and dried samples are presented in Table 1, and Table 2 respectively. In this experiment, the initial moisture content of fresh sweet potatoes was found to be 67.22 %, whereas the moisture content of dried sweet potatoes varied from 4.89 % to 7.78 %. The findings corroborate with the observation of Rodrigues et al., 2016. The ash content in fresh sweet potatoes was 1.01 % which was increased for all drying methods and the values varied from 1.89 %, 2.20 %, and 2.42 % for sun, cabinet, and freeze-dried sweet potatoes, respectively. These experimental observations for ash content were close to the values reported by Mohammad et al., 2016. The present study reveals that the anthocyanin content of freeze-dried sweet potatoes (0.63 mg/100 g) was significantly higher than other samples. Our findings were lower than the previous study by Rodríguez-Mena et al., 2023. Results also showed that the β-carotene and ascorbic acid

content of freeze-dried sweet potatoes were significantly higher than sun and cabinet-drying samples. The total phenolic content for sun drying, cabinet, and freeze drying was 18.49, 19.49, and 25.07 mg/100 g, respectively. The carotenoid content of freeze-dried sweet potatoes (2.79 mg/100 g) was significantly higher than sun and cabinet-dried samples (2.18, 2.42 mg/100 g respectively). The color attributes for sun drying, cabinet, and freeze drying were significant, and the findings were covenant with a former study by Bakar et al., 2022. The results revealed that the water absorption capacities of the sun, cabinet, and freeze-dried sweet potatoes were 130.89, 154.89, and 181.33 % respectively and oil absorption capacities were 121.22, 130.56, and 162.67 % respectively. WAC and OAC are useful in structure interaction in food, especially in flavor retention, palatability improvement, and shelf-life extension particularly in bakery products (Adebowal and Lawal, 2004).

Conclusion

The physicochemical characteristics of fresh and dried sweet potatoes varied considerably. The losses of nutritional quality throughout the freeze-drying process were minimal compared to cabinet and sun drying. Freeze-dried samples were found to be desirable in color retention and nutritional qualities. Finally, it can be suggested that dried sweet potatoes may be utilized as a raw material for further commercial uses in the food processing industry.

Table

Table 1. Nutritional parameters and color characteristics of fresh sweet potatoes

Parameters	Fresh	Parameters	Fresh
Moisture Content (%)	67.22 ± 0.18	Phenolic content (mg/100 g)	5.95 ± 0.64
Ash (%)	1.01 ± 0.04	Carotenoid (mg/100 g)	2.38 ± 0.15
Anthocyanin (mg/100 g)	0.35 ± 0.02	L	36.34 ± 0.21
β-carotene (mg/100 g)	8.21 ± 0.84	a*	17.04 ± 0.74
Ascorbic acid (mg/100 g)	11.61 ± 1.20	b*	2.03 ± 0.46

All values are mean ± S.D. of triplicate determinations.

Table 2. Nutritional parameters, color and functional properties of dried sweet potatoes

Parameters	Sun Drying	Cabinet Drying	Freeze Drying
Moisture Content (%)	7.78 ± 0.60^{a}	6.15 ± 0.60^{b}	4.89 ± 0.16^{c}
Ash (%)	1.89 ± 0.07^{c}	2.20 ± 0.02^{b}	2.42 ± 0.02^{a}
Anthocyanin (mg/100 g)	0.38 ± 0.02^{c}	0.47 ± 0.02^{b}	0.63 ± 0.02^{a}
β-carotene (mg/100 g)	18.58 ± 0.70^{b}	21.82 ± 0.93^{b}	49.69 ± 2.69^{a}
Ascorbic acid (mg/100 g)	13.80 ± 0.72^{b}	16.53 ± 0.50^{a}	17.47 ± 1.14^{a}
Phenolic content (mg/100 g)	18.49 ± 0.97^{b}	19.49 ± 0.65^{b}	25.07 ± 0.65^{a}
Carotenoid (mg/100 g)	2.18 ± 0.14^{b}	2.42 ± 0.15^{ab}	2.79 ± 0.22^{a}
L	60.69 ± 0.06^{b}	57.86 ± 0.06^{c}	63.48 ± 0.07^{a}
a*	11.99 ± 0.03^{a}	7.02 ± 0.01^{c}	8.80 ± 0.01^{b}
b*	4.70 ± 0.01^{c}	13.76 ± 0.01^{a}	10.15 ± 0.01^{b}
WAC (%)	130.89 ± 0.70^{c}	154.89 ± 1.50^{b}	181.33 ± 1.20^{a}
OAC (%)	121.22 ± 1.35^{c}	130.56 ± 1.17^{b}	162.67 ± 1.34^{a}

All values are mean ± S.D. of triplicate determinations. This means that columns with different letters a, b, and c indicate significant results ($p \leq 0.05$).

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DEVELOPMENT OF BAKERY PRODUCTS FROM SWEET POTATO FLOUR AND EVALUATION OF ITS QUALITY

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Abstract

The blending of wheat flour with sweet potato flour (SPF) in five different formulations (10 %, 20 %, 30 %, 40 %, and 50 %) was used to produce composite biscuits, and control was considered without the addition of SPF. The physical properties of composite biscuits in weight, diameter, and thickness were increased with the enhancement of incorporated SPF flour. Among all formulations, T_6 biscuit samples showed more hardness (34.25 N) indicating that hardness increased with the increase of substitution and provided significantly higher amounts of energy than other formulations. The control and developed biscuits were subjected to evaluate sensory attributes according to a nine-point hedonic scale. Results also depicted that overall acceptability for composite biscuits achieved the maximum score for T_6 followed by T_5, T_4, T_3, and T_2 as compared to the control (T_1). Sensory attributes of composite biscuits also revealed that there was a significant difference ($P \leq 0.05$) in color, flavor, taste, texture, and overall acceptability.

Introduction

Sweet potato has a short lifespan and is difficult to store for a long time. There are many problems with the storage and transportation of raw sweet potatoes in our country. It is the most versatile, and under-exploited food crop with more than 90 million tons in annual production, contributed mostly by Asian and African countries (FAOSTAT, 2020). It is an indispensable source of valuable nutrients such as dietary fiber, ascorbic acid, β-Carotene, minerals, and bioactive compounds (e.g., carotenoids, polyphenols, anthocyanin) (Islam et al., 2016; Sun et al., 2019). Sweet potato flour can partially substitute wheat flour in baked goods such as bread, cakes, biscuits, cookies, and noodles as a substitute for cereal products (Van, 2000). It may be used to improve baked foods' color, taste, sweetness, and nutrient content. If it can be properly utilized as a raw material in the food industry, it will minimize the postharvest losses of sweet potatoes by introducing nutritious and value-added food products available throughout the year.

Materials and Methods

Sweet potatoes will be collected from TCRC, BARI. Then, prepared sweet potato flour can be utilized to develop food products according to the treatments. The weight and thickness of the control and developed biscuits were determined using the technique of Ayo et al., (2007). The diameter of the food products was measured according to the procedure of AACC (2000). The spread ratio was measured by dividing the diameter by thickness (Bala et al., 2015). The textural profile of biscuits was assessed using a texture analyzer described by Kesselly et al. (2024) with slight modification. The color attributes of biscuits were determined using a colorimeter according to the guidelines established by Medhe et al. (2019). The energy content of the nutritious biscuits was determined according to the method described by Henken et al. (1986) by using a Parr 6100 Calorimeter. Sensory attributes of the biscuit samples were evaluated according to the method described by Olatoye et al. (2020) with modification.

Results and Discussion

The weight of the control and developed biscuits ranged from 11.28 to 11.85 g with a maximum value in T_6. The diameter of biscuits sample T_3 was found slightly higher and other samples were lower than that of control biscuits. The thickness of the biscuits ranged from 0.79 to 0.85 cm. The changes in diameter and thickness were reflected in the spread ratio. The spread ratio the of control biscuit was 7.91, whereas T_2, T_3, T_4, T_5, and T_6 showed lower spread ratios. The energy content of the T_6 biscuits was significantly higher than other treatments. The quality of the biscuits is primarily defined by color and textural profile. Results revealed that the color of the biscuits was significant. The trend of diminishing the color of biscuits with higher incorporation of SPF. The color and textural profile of the biscuits prepared from the composite flour is shown in Table 2. Results revealed that the incorporation of SP flour increased the hardness of the biscuits. Control biscuits had a hardness value of 21.97 N which increased to 23.71 N in T_2, 24.68 N in T_3, 26.17 N in T_4, 27.09 N in T_5, and 34.25 N in T_6. Results also depicted that overall acceptability for composite biscuits achieved the maximum

score for T_6 followed by T_5, T_4, T_3, and T_2 as compared to the control (T_1). Sensory attributes of composite biscuits also revealed that there was a significant difference ($P \leq 0.05$) in color, flavor, taste, texture, and overall acceptability.

Conclusion

Finally, it can be concluded that sweet potato flour incorporation of up to 50 % (T_6) showed good overall acceptability with a distinctive color and provided significantly higher amounts of energy than other formulations.

Table

Table 1. Physical analysis and energy content of the biscuit samples

Biscuit Samples	Physical Parameters				Energy (Cal/g)
	Weight (g)	Diameter (cm)	Thickness (cm)	Spread ratio	
T_1	11.28 ± 0.01^{e}	6.25 ± 0.02^{a}	0.79 ± 0.01^{c}	7.91 ± 0.02^{a}	7667.87 ± 6.14^{f}
T_2	11.62 ± 0.01^{d}	6.21 ± 0.02^{ab}	0.80 ± 0.01^{c}	7.76 ± 0.13^{a}	8315.12 ± 7.05^{e}
T_3	11.65 ± 0.01^{d}	6.71 ± 0.01^{bc}	0.80 ± 0.01^{c}	7.71 ± 0.11^{a}	8498.94 ± 6.79^{d}
T_4	11.69 ± 0.01^{c}	6.14 ± 0.12^{c}	0.82 ± 0.01^{b}	7.46 ± 0.05^{b}	8680.46 ± 7.19^{c}
T_5	11.74 ± 0.02^{b}	6.09 ± 0.02^{d}	0.83 ± 0.01^{b}	7.31 ± 0.04^{b}	8881.89 ± 5.16^{b}
T_6	11.85 ± 0.01^{a}	6.04 ± 0.01^{e}	0.85 ± 0.01^{a}	7.08 ± 0.04^{c}	9073.30 ± 8.10^{a}

All values are mean ± S.D. of triplicate determinations. This means that rows with different letters a, b, c, d, e, and f indicate significant results ($p \leq 0.05$).

Table 2. Color parameters and textural profile of biscuit samples

Biscuit Samples	Color Measurement			Textural Profile
	L*	a*	b*	Hardness (N)
T_1	48.24 ± 0.18^{a}	16.16 ± 0.13^{a}	33.17 ± 0.15^{a}	21.97 ± 0.11^{f}
T_2	43.82 ± 0.03^{b}	15.26 ± 0.08^{b}	30.60 ± 0.18^{b}	23.71 ± 0.46^{e}
T_3	39.41 ± 0.57^{c}	12.08 ± 0.47^{c}	22.99 ± 0.73^{c}	24.68 ± 0.03^{d}
T_4	34.59 ± 0.08^{d}	9.91 ± 0.05^{d}	20.45 ± 0.10^{d}	26.17 ± 0.01^{c}
T_5	31.29 ± 0.16^{e}	7.57 ± 0.12^{e}	20.54 ± 0.18^{d}	27.09 ± 0.01^{b}
T_6	26.08 ± 0.24^{f}	4.13 ± 0.03^{f}	16.22 ± 0.22^{e}	34.25 ± 0.01^{a}

All values are mean ± S.D. of triplicate determinations. This means that rows with different letters a, b, c, d, e, and f indicate significant results ($p \leq 0.05$).

Table 3. Organoleptic tests of biscuit samples

Biscuit Samples	Appearance	Color	Flavor	Taste	Texture	Overall Acceptability
T_1	6.00 ± 1.25^{c}	5.90 ± 1.37^{b}	5.75 ± 1.16^{b}	6.00 ± 1.12^{b}	6.10 ± 1.25^{b}	5.95 ± 0.92^{c}
T_2	6.25 ± 1.33^{bc}	6.55 ± 0.89^{b}	6.60 ± 0.88^{ab}	6.80 ± 1.01^{ab}	6.85 ± 0.75^{ab}	6.61 ± 0.71^{bc}
T_3	7.25 ± 1.16^{ab}	6.90 ± 1.07^{ab}	6.85 ± 1.46^{a}	7.05 ± 1.09^{a}	6.60 ± 1.23^{b}	6.93 ± 0.94^{ab}
T_4	6.50 ± 1.00^{abc}	6.75 ± 0.97^{b}	6.80 ± 0.89^{a}	6.90 ± 1.02^{ab}	6.15 ± 0.75^{b}	6.62 ± 0.68^{bc}
T_5	6.60 ± 1.14^{abc}	6.80 ± 1.47^{ab}	6.80 ± 1.15^{a}	6.75 ± 1.33^{ab}	6.75 ± 1.45^{ab}	6.74 ± 1.18^{bc}
T_6	7.50 ± 1.10^{a}	7.85 ± 1.09^{a}	7.50 ± 0.51^{a}	7.45 ± 0.94^{a}	7.70 ± 0.98^{a}	7.60 ± 0.81^{a}

All values are mean ± S.D. of triplicate determinations. This means that rows with different letters a, b, and c indicate significant results ($p \leq 0.05$).

Reference

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EFFECT OF COATINGS ON THE PHYSICOCHEMICAL PROPERTIES OF AIR FRIED JACKFRUIT CHIPS

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Abstract

This study investigated the impact of different treatments on various physicochemical properties of air fried jackfruit chips. Five treatments were evaluated for their moisture content (MC), ash content, pH, total soluble solids (TSS), acidity, and vitamin C levels. Additionally, energy content, carotenoid, phenol levels, and color attributes (L*, a*, b*) were analyzed. Results revealed significant variations across treatments. Control samples exhibited the lowest moisture content (3.46%) and ash content (1.21%), with moderate pH (6.13) and TSS (3.70). It also had the lowest acidity (0.51%) and vitamin C (3.66 mg). Maltodextrin treatment showed the highest moisture content (7.12%) and energy (6260.63 kJ), with the highest TSS (4.13) and acidity (1.02%). Sugar flour coating presented high carotenoid levels (21.63 mg) and vitamin C (4.33 mg), alongside a high TSS (4.63) and pH (6.14). Rice flour coatings had the highest ash content (1.60%) and exhibited the highest color parameter L* (53.14), indicating a lighter color, while corn flour coated samples displayed the highest vitamin C content (7.33 mg) and lowest color parameter b* (28.95), indicating a more intense color. The findings highlight the significant differences in physicochemical properties among treatments, suggesting varying nutritional and sensory profiles that may influence the choice of treatment based on desired product characteristics.

Introduction

Jackfruit (*Artocarpus heterophyllus*), renowned as the largest edible fruit globally, is highly valued for its exceptional nutritional profile. It holds a prestigious status as the national fruit of Bangladesh, reflecting its cultural and economic significance. In the fiscal year 2016-17, Bangladesh emerged as the second-largest producer of jackfruit, contributing approximately 0.95 million tons to the global market. Despite its prominence, a staggering 45% of this valuable fruit is wasted annually (BBS, 2018). Given that jackfruit constitutes 25% of the country's total fruit production, this substantial loss underscores a pressing issue that warrants attention. The high rate of wastage presents a critical challenge, emphasizing the urgent need for innovative solutions to harness the fruit's full potential. One promising approach involves leveraging the increasing consumer preference for fried products while addressing health concerns associated with traditional frying methods. The growing popularity of fried foods is accompanied by mounting health concerns, primarily due to their high fat content. This has prompted a search for healthier alternatives that can provide the same satisfying sensory experience without compromising nutritional value. Air frying presents a viable solution by offering a method to produce lower-fat snacks while preserving the traditional flavor and texture characteristics of fried products.

In this context, air-fried jackfruit bulb chips emerge as an innovative option. By utilizing air frying technology, these chips can be prepared with reduced fat content, aligning with the modern demand for healthier snack alternatives. Moreover, jackfruit is known for its rich nutritional profile, including vitamins, minerals, and dietary fiber, which can be retained in air-fried chips, making them a valuable addition to the diet.

This study aims to evaluate the effectiveness of various coatings on air-fried jackfruit chips and assess their quality characteristics. By exploring different coating techniques, the research seeks to optimize the sensory and nutritional attributes of the chips, providing a practical solution to reduce jackfruit wastage and meet consumer demand for healthier snack options. The findings will contribute to enhancing the utilization of this underappreciated fruit and support the development of sustainable and nutritious food products.

Materials and methods

In this research work, physiologically matured khaja type jackfruits BARI Kathal -2 were collected from the local market and sorted for pre-treatment. Jackfruits were sorted out from any harvesting and transportation injured and cleaned by washing with potable water. After peeling and decoring, the jackfruit bulbs were separated. The internal seed was removed by cutting into halves with sharp knives and then sliced at 5 mm thickness. After that jackfruit slices were sealed in HDPE packets and frozen at -18°C in deep fridge for 24-48 hrs. Then stored jackfruit strips were dipping into 10% solutions of maltodextrin, rice flour, corn flour and corn flour for half an hour. Then the coated jackfruit strips were subjected to drying after blanching treatment to reduce the initial moisture content (Sansano *et al.*, 2015). For final air frying experiments, 0.45 gm of oil per 100 gm of jackfruit was added and frying methodology by Andres *et al*. (2013) was followed. After frying activities, the chips were cooled down to room temperature for 10 min and packaged in high-density polyethylene packaging bags with nitrogen flashing.

Moisture content, total soluble solids (TSS), ash, pH were determined according to the method described by AOAC (2005). Lycopene and β-carotene content was determined by Nagata and Yamashita (1992). The color parameters were assessed according to Dervisi *et al.* (2001).

Results and Discussion

In evaluating the effects of different coatings on the properties of chips, distinct variations were observed across several parameters in Table 1 and Table 2. Each coating treatment influenced these characteristics in specific ways, which can be explained by the physicochemical properties of the ingredients used.

Table 1. showed the summary of physicochemical properties including moisture content, ash, pH, TSS, acidity, vit C values across different treatments

Treatments	MC	Ash	pH	TSS	Acidity	Vit C
T_1: Control	3.46 ± 0.3^{a}	1.21 ± 0.02^{a}	6.13 ± 0.005^{b}	3.70 ± 0.10^{b}	0.51 ± 0.001^{a}	3.66 ± 0.57^{ab}
T_2: Maltodextrin	7.12 ± 0.14^{d}	1.37 ± 0.05^{b}	6.03 ± 0.01^{a}	4.13 ± 0.05^{c}	1.02 ± 0.0001^{b}	3.66 ± 0.57^{a}
T_3: Sugar Flour	6.62 ± 0.19^{cd}	1.23 ± 0.04^{a}	6.14 ± 0.01^{b}	4.63 ± 0.15^{d}	0.51 ± 0.001^{a}	4.33 ± 0.57^{b}
T_4: Rice flour	6.41 ± 0.25^{c}	1.60 ± 0.01^{c}	6.43 ± 0.005^{c}	3.46 ± 0.11^{ab}	0.51 ± 0.001^{a}	5.66 ± 0.57^{bc}
T_5: Corn Flour	5.52 ± 0.16^{b}	1.17 ± 0.03^{a}	6.46 ± 0.05^{c}	3.36 ± 0.05^{a}	0.51 ± 0.002^{a}	7.33 ± 0.57^{d}

Table 2. showed the summary of physicochemical properties including energy, carotenoids, phenol and color values across different treatments

Treatments	Energy	Carotenoids	Phenol	L^*	a^*	b^*
T_1: Control	6297.61 ± 0.43^{b}	22.99 ± 0.13^{e}	12.54 ± 0.02^{d}	46.33 ± 0.36^{a}	9.77 ± 0.08^{a}	32.19 ± 0.52^{b}
T_2: Maltodextrin	6260.63 ± 0.01^{a}	17.59 ± 0.12^{a}	12.06 ± 0.01^{b}	47.73 ± 0.40^{b}	11.37 ± 0.24^{a}	35.68 ± 0.20^{cd}
T_3: Sugar Flour	6367.38 ± 0.01^{e}	21.63 ± 0.12^{d}	12.34 ± 0.01^{c}	51.71 ± 0.75^{c}	8.23 ± 0.09^{b}	34.82 ± 2.09^{bc}
T_4: Rice flour	6352.13 ± 0.05^{c}	19.31 ± 0.11^{c}	12.37 ± 0.01^{c}	53.14 ± 0.52^{d}	9.46 ± 0.06^{b}	37.74 ± 0.20^{d}
T_5: Corn Flour	6359.56 ± 0.00^{d}	18.45 ± 0.22^{b}	10.84 ± 0.03^{a}	45.66 ± 0.23^{a}	7.45 ± 0.62^{c}	28.95 ± 0.29^{a}

Maltodextrin-coated chips exhibited the highest moisture content due to maltodextrin's hygroscopic nature, which allows it to retain water. In contrast, control chips had the lowest moisture and ash content, indicating that the absence of a coating reduces their ability to retain moisture or minerals. Rice flour-coated chips showed the highest ash content, possibly due to their inherent mineral content. These results suggest that coatings act as barriers affecting moisture retention and mineral composition. Maltodextrin-coated chips were the most acidic, with a pH of 6.03 and titratable acidity of 1.02%, likely due to the breakdown of maltodextrin during frying, forming organic acids. Rice and corn flour coatings resulted in chips with pH levels closer to neutral and similar acidity, indicating that flour-based coatings do not significantly contribute to acid formation. The sugar flour coating had the highest total soluble solids (TSS) (4.63±0.15), likely due to added sugars, while maltodextrin increased TSS moderately (4.13±0.05). Control chips had a moderate TSS level (3.70±0.10), while rice flour (3.46±0.11) and corn flour (3.36±0.05) produced the lowest TSS values, reflecting the lower solubility of starches. Energy content varied significantly, with sugar flour-coated chips having the highest energy value, while maltodextrin-coated chips had the lowest. Control chips retained the highest levels of carotenoids and phenols, with maltodextrin and corn flour coatings reducing these bioactives. Rice flour-coated chips were the lightest in color, while corn flour produced the darkest hue, influenced by the Maillard reaction and caramelization during frying.

Conclusion

This study evaluated the impact of five different treatments on various physicochemical properties of food products. different treatments significantly impact the physicochemical characteristics of the food products, suggesting that specific treatments can be selected based on desired attributes such as moisture content, acidity, nutritional value, and color. The variation observed in vitamin C and carotenoid levels among treatments highlights the potential for tailoring product characteristics to meet specific nutritional and sensory preferences.

Reference

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STANDARDIZATIONS OF MIXED FOXTAIL MILLET-JACKFRUIT SOURDOUGH BREAD

P. Sen, M.H.H. Khan, M.M. Rahman, M.G.F. Chowdhury, M.M. Molla, S. Pervin, B.C. Dey

Abstract

This study investigated the impact of varying proportions of millet and jackfruit flours on the physicochemical and physical properties of sourdough bread. Six formulations (T_1–T_6) were analyzed for moisture content, ash, pH, total soluble solids (TSS), acidity, phenol content, carotenoids, energy value, color parameters (L*, a*, b*), and bread dimensions (specific volume, height, diameter, weight, and volume). Results indicated that moisture and carotenoid content increased with jackfruit flour, while millet flour enhanced phenolic content, acidity, and reduced energy value. The combination of millet and jackfruit flour significantly influenced bread structure, with wheat-based bread (T_1) showing the highest specific volume, while millet-rich breads were flatter with greater diameter. Jackfruit flour lightened the bread color, contributing to higher yellowness, while millet darkened it. T_4 (50% millet: 50% jackfruit) offered a balanced profile in terms of flavor, nutrition, and physical attributes. These findings suggest that millet and jackfruit flour can enhance the nutritional value and sensory qualities of gluten-free sourdough bread, making it a viable alternative for health-conscious consumers.

Introduction

Foxtail millet (*Setaria italica* L. *Beauv.*) is a valuable yet underutilized crop known for its drought resistance and rich nutritional profile, making it well-suited for warmer, drier climates. Likewise, jackfruit thrives in the climate of Bangladesh and is renowned for its flavor and nutritional benefits. However, both crops face challenges such as low economic returns and high post-harvest losses. To address these issues, processing foxtail millet and jackfruit into flour could expand their market appeal and utility. Yet, health-conscious consumers often struggle to find bakery products that are both nutritious and low in sugar and oil.

Sourdough bread, with its natural fermentation process involving wild yeast and lactic acid bacteria, offers a promising alternative due to its ability to lower the glycemic index (GI) and improve nutrient bioavailability. The low gluten content also enhances digestibility. Developing a sugar- and oil-free sourdough bread using a blend of foxtail millet and jackfruit flour could address both agricultural and consumer needs by providing a healthy, year-round option. This study aims to create and evaluate a suitable formulation of foxtail millet-jackfruit flour sourdough bread, ensuring it meets nutritional and sensory expectations.

Materials and methods

BARI Kaun- 4 was collected from Plant Breeding Division, Gazipur then de-husked from FMPE division to prepare flour. BARI Kathal -2 was collected from farmers' fields. After peeling and decoring, the jackfruit bulbs were separated and dried into 65℃ for preparing flour. For standardization of mixed Foxtail Millet-Jackfruit sourdough bread, different treatments as T_1: Wheat flour (100); T_2: Millet Flour : Jackfruit Flour (0:100); T_3: Millet Flour : Jackfruit Flour (25:75); T_4: Millet Flour : Jackfruit Flour (50:50); T_5: Millet Flour : Jackfruit Flour (75:25); T_6: Millet Flour : Jackfruit Flour (100:0) were used. To make small batch sourdough bread, start by mixing 250 g bread flour, 175 g water, 50 g sourdough starter, and 5 g salt in a bowl to form a shaggy dough. Cover and let it rest for 1 hour (autolyse). Then, shape the dough into a smooth ball and let it rest for 30 minutes. Perform 4-6 stretch and folds, with 15 minutes between sets. Let the dough bulk ferment, covered with plastic, until it doubles in size. Shape the dough into a ball, place it in a floured proofing basket, and refrigerate for 5-36 hours. Preheat the oven to 230°C (450°F) with a Dutch oven inside. Score the dough and bake it for 30 minutes with the lid on, then 10-15 minutes with the lid off at 210°C (410°F). Cool on a wire rack before slicing.

Result and discussion

The study examined the physicochemical properties and physical characteristics of sourdough bread were made with varying proportions of millet and jackfruit flours (T1–T6). The Table 1, Table 2 and Table T3 present the comparison of different physicochemical parameters across various treatments.

Moisture content increased with jackfruit flour, with T_6 (100% millet) showing the highest and T_1 (100% wheat) the lowest. Ash content, representing mineral composition, was highest in T_1, while jackfruit flour increased the bread's carotenoid content. pH remained stable across treatments, showing minimal impact from flour variations. TSS values peaked in T_4 (50% millet: 50% jackfruit), highlighting a favorable sugar profile. Acidity increased with millet content, suggesting enhanced sourness in millet-based breads, while phenolic content, an indicator of antioxidant potential, was highest in T_6, indicating health benefits from millet-rich formulations. Regarding physical characteristics, T_1 had the highest specific volume, producing lighter, airier bread, while T_2 (100% jackfruit) was denser with a lower specific volume. Jackfruit flour also contributed to greater bread height but with lower volume. Millet flour tended to create wider, flatter loaves. T_5 and T_6, with higher millet content, showed the largest diameters. Energy content decreased with higher millet flour proportions, with T_1 having the highest and T_6 the lowest caloric values. Color analysis revealed that jackfruit flour lightened the bread and increased yellowness, while millet flour darkened the color.

Table 1. Comparison of Various Parameters in Different Treatments

Treatments**	MC	Ash	pH	TSS	Acidity	Phenol
T_1	21.47±.88a	1.92±.035d	5.04±.015a	2.47 ± 0.06b	0.256 ± 0.001f	4.00 ± 1.19c
T_2	27.67±.85c	1.77±.015b	5.17±.01a	2.53 ± 0.12b	0.384 ± 0.001e	5.73 ± 0.01a
T_3	33.79±.28e	1.80±.015b	5.12±.01a	2.53 ± 0.06b	0.271 ± 0.017b	3.44 ± 0.00b
T_4	24.97±.925b	1.86±.025c	5.55±.01b	2.80 ± 0.00c	0.384 ± 0.00d	4.14 ± 0.00d
T_5	25.71±.381bc	1.65±.015a	5.16±.21a	2.37 ± 0.06a	0.512 ± 0.001c	11.30 ± 0.00e
T_6	30.82±.767d	1.63±.005a	5.10±.005a	2.27 ± 0.06a	0.767 ± 0.002a	12.33 ± 0.00f

Table 2. Comparison of Carotenoids, Energy, and Color Parameters Across Treatments

Treatments**	Carotenoids	Energy	L*	a*	b*
T_1	9.98 ± 0.05c	5745.54 ± 2.53f	42.63 ± 0.15a	10.81 ± 0.14d	16.16 ± 0.08a
T_2	9.25 ± 0.07b	5428.03 ± 1.82e	57.26 ± 0.24f	8.05 ± 0.17a	26.27 ± 0.56d
T_3	15.27 ± 0.10e	5075.71 ± 0.99b	50.28 ± 0.22b	10.38 ± 0.14c	22.44 ± 0.29c
T_4	8.25 ± 0.05a	5140.86 ± 0.00d	53.62 ± 0.23d	9.73 ± 0.05b	22.93 ± 0.06c
T_5	9.19 ± 0.05b	5092.43 ± 0.56c	51.62 ± 0.08c	8.14 ± 0.07a	20.74 ± 0.42b
T_6	10.50 ± 0.04d	4757.52 ± 0.01a	56.02 ± 0.19e	7.98 ± 0.14a	20.46 ± 0.27b

Table 3. Physical Characteristics of Bread Samples Across Treatments

Treatments**	Specific Volume	Height	Diameter	Weight	Volume (In3)	Volume (cm3)
T_1	3.85 ± 0.00	1.98 ±0.87	16.50 ± 0.00	350.00 ± 0.00	82.16 ± 0.00	1346.34 ± 0.00
T_2	1.45 ± 0.00	8.30 ± .00	15.70 ± 0.00	300.00 ± 0.00	26.46 ± 0.00	433.52 ± 0.00
T_3	1.52 ± 0.00	5.20 ± .00	15.70 ± 0.00	280.00 ± 0.00	26.02 ± 0.00	426.42 ± 0.00
T_4	1.72 ± 0.00	4.60 ± .00	15.60 ± 0.00	325.00 ± 0.00	34.21 ± 0.00	560.61 ± 0.00
T_5	1.55 ± 0.00	4.80 ± .00	18.00 ± 0.00	315.00 ± 0.00	29.75 ± 0.00	487.43 ± 0.00
T_6	1.80 ± 0.00	4.70 ± .00	18.00 ± 0.00	325.00 ± 0.00	35.79 ± 0.00	586.52 ± 0.00

**T_1: Wheat flour (100); T_2: Millet Flour : Jackfruit Flour (0:100); T_3: Millet Flour : Jackfruit Flour (25:75); T_4: Millet Flour : Jackfruit Flour (50:50); T_5: Millet Flour : Jackfruit Flour (75:25); T_6: Millet Flour : Jackfruit Flour (100:0)

Conclusion

In conclusion, substituting millet and jackfruit flours in sourdough bread affects its physicochemical and physical properties significantly. Millet flour boosts phenolic content and reduces energy value, while jackfruit flour adds moisture and carotenoids, enhancing nutritional value and sensory appeal. Wheat-based bread is lighter and airier, while millet and jackfruit flour produce denser, flatter loaves with unique textures. A balanced mixture of both flours offers an optimal combination of flavor, nutrition, and appearance for gluten-free, nutrient-dense bread.

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