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THE EFFECT OF PROCESSING TECHNIQUES ON THE SHELF LIFE, NUTRITIONAL AND SENSORY QUALITY OF GINGER (*Zingiber officinale*) POWDER AND PASTE

M.J. RAHMAN[1*], M.A.I. TALUKDER[2], L. RANI[1], K.C. SAHA[3] AND M.S.I. NAHID[2]

[1]Department of Food Processing and Preservation, Hajee Mohammad Danesh Science and Technology University (HSTU), Dinajpur, Bangladesh; [2]Department of Agricultural Chemistry, Hajee Mohammad Danesh Science and Technology University (HSTU), Dinajpur, Bangladesh; [3]Department of Agricultural Chemistry, Shahid Akbar Ali Science and Technology (SAST) College, Thakurgaon, Bangladesh.

[*]Corresponding author & address: Md. Jiaur Rahman, E-mail: jia.hstu@yahoo.com
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ABSTRACT

Rahman MJ, Talukder MAI, Rani L, Saha KC, Nahid MSI (2013) The effect of processing techniques on the shelf life, nutritional and sensory quality of ginger (*Zingiber officinale*) powder and paste. *J. Innov. Dev. Strategy.* 7(3), 60-66.

The main objective of this study was to investigate the effect of different processing techniques such as storing at room temperature and refrigeration temperature both having a treatment with 750 ppm Sodium Benzoate as preservative on the shelf life of ginger powder and ginger paste during storage which were packaged in low density polyethylene (LDPE) and high density polyethylene (HDPE) packages. The nutritional quality in terms of proximate compositions, Vitamin-C and sensory preferences of ginger powder and ginger paste were also assessed. The ginger powder samples stored at room temperature in HDPE bags showed the highest stability up to 150 days while in case of ginger paste samples the highest stability was obtained up to 120 days when stored in refrigerator. A significant effect of the processing techniques was found in relation to proximate compositions except vitamin-C and sensory preferences at $p<0.05$. It was observed that vitamin-C content of ginger paste in HDPE bag found slightly higher when stored in refrigeration temperature than in room temperature. Storage using HDPE bag was found best in respect of color, flavor and texture than LDPE bag. The overall acceptability of the ginger powder that packaged in LDPE bags and HDPE bags were found more than ginger paste. Moreover ginger paste which was stored in refrigeration temperature found more acceptable than ginger paste that was stored in room temperature. The findings of the present study may help in developing commercial processing technology of ginger powder and paste for effective utilization by improving storage condition.

Key words: *ginger powder, ginger paste, shelf life, nutritional quality, sensory evaluation*

INTRODUCTION

Ginger (*Zingiber officinale*) belongs to the family *Zingiberaceae* is an important spice of Bangladesh locally called as ‘ada’. Ginger has high medicinal value and used in Allopathic and Hamdard medicine, it is widely used as spice in Bangladesh (Parry 2000).

It is originated in the Southeast Asia and is a crop of very ancient cultivation. It is one of the earliest oriental spices known to Europe and is still in the large demand today.

The largest ginger producing country is India, which produces about 5% of the world’s total production and is the largest exporter. In India, the total annual production of ginger was 385,330 metric tons (FAO 2012). Other important producers are China, Nepal, Thailand, Nigeria and Indonesia.

In Bangladesh, ginger grows well in Rangpur, Nilphamari, Khulna, Rangamati, Bandharban and Khagrachori districts. The total area of cultivation and the annual production of ginger were 22,000 acres and 80,000 metric tons respectively (BBS 2010). On the other hand the total area of cultivation and annual production were 22,400 acres and 74.841metric tons respectively (FAO 2012).

The aroma of ginger is pleasant and spicy and its flavor penetrating, slightly biting due to presence of antiseptic or pungent compounds, which make it indispensable in the manufacture of a number of food products like ginger bread, confectionary, ginger ale, curry powders, certain curried meats, table sauces, in pickling and the manufacture of certain soft drinks like cordials, ginger cocktail, carbonated drinks, bitters, etc. Ginger is also used for the manufacture of ginger oil, oleoresin, essences, tinctures etc. (Pruthi 2006).

Ginger is seasonal in nature and available in large quantities during the peak season in the local market. In relation to spice and /or food, we have two major problems in Bangladesh. One is insufficient production and the other is post-harvest losses. If spoilage/post-harvest losses could be reduced to an acceptable level by proper preservation, farmers would get proper price of their products and thus be encouraged to increase yield and production. Only a small portion of ginger produced is processed and preserved by housewives and small processors by traditional method like sun drying. Thus, it is seen that the primary obstacle to production and consumption of increased amount of spices is the lack of suitable preservation method.

Bangladesh cannot use high technology, sophisticated machineries or equipment, skilled manpower and large capital investment for modern food processing industries as in developed countries. Therefore, it is of paramount importance to develop and use low level appropriate technology for processing and preservation of spices and other food items made from ginger. Processing ginger into dried product is an important method of reducing perishability and also to increase storage stability. Drying is one of the most widely used methods of food preservation and its success largely depends on the reconstitution properties of the dried products. Since the dried product will be acceptable as food uses only, if it after reconstitution possesses, attractive good color, flavor, texture and desired nutrition value. Purseglove and Brown (1998) found that the crude fiber content of unpeeled may be as high as 10 percent (on a dry basis), but in commercial dried ginger it is usually 1-3 percent. Commercial dried gingers have been reported to provide oleoresins in yields of 3.5-10 percent and to contain 15-30 percent of volatile oil (Wintertonand and Richardson, 1995). The pungent principle content of the oleoresins in again less certain owing to short comings in analytical methods but it is believed to be in the range of 17-30 percent for fresh extracts (Nambudri and Marthew, 1975).

According to Okafor and Okafor (2007), dried ginger is traded traditionally in whole split form is used in wide range of foods when grounded into powdery form and used for preservation of meat, baking spice, soups and puddings. Most of the world's ginger is processed into concentrates for the manufacture of ready-to-serve ginger drinks which can be alcoholic or non-alcoholic (Yiljep *et al.* 2005).

Sun drying is the traditional method of preservation that takes longer time and depends on the weather condition. So, to achieve faster drying and to avoid uncertain weather condition, the mechanical drying method can be used for ginger preservation. In mechanical dryer, desired temperature could be maintained and higher temperature could be utilized than sun drying. This leads to high production rates and improved quality products due to shorter drying time and reduction of insect infestation and microbial spoilage.

Ginger powder is used to flavor all kinds of foods. It is included in foods such as cakes, ginger cookies, gingerbread, pies, jams, candy, beer, and ginger ale soda. Ginger powder is often added to savory dishes such as meats, vegetables, rice, tofu, marinades, sauces, curry pastes, stir fries, ginger tea and soups. Ginger powder is a perfect addition to marinades. Addition of ginger powder to dishes at the beginning of cooking increases the flavor.

The ginger paste, as a convenience food ingredient, may find its widespread use in the catering industry as well as in the home. The catering industry is itself made up of a variety of outlets such as hotels, restaurants, canteens, hospitals, nursing homes, school meals and prisons. The ginger paste, for its anticipated widespread use, may help fill the needs of consumers for a convenient food ingredient. In Bangladesh there are only few published studies on ginger processing. Therefore in this study our principle concern was to investigate the effect of processing techniques on the storage stability and overall acceptability of the processed ginger powder and ginger paste.

MATERIALS AND METHODS

Collection and preparation of sample

Ginger powder

Fresh gingers were collected in the laboratory from local markets in order to conduct our research. The samples were washed thoroughly with tap water to remove dust, grease and latex and other impurities. After peeling of the samples thin slices were made of 2-3mm thickness which was blanched with boiled water for 3 minutes. The sample was then dried in cabinet dryer at 60^{o}C for 20 hours containing 6-10% moisture and cooled at room temperature. Sieving of the sample was done after Blending with the help of laboratory used mechanical blender. The dried sample was packed using low density polythene bags & air tight plastic container and stored at room temperature (25-30^{0}C). Analysis of the sample for quality evaluation was done in 60, 120 and 180 days of storage.

Ginger paste

After making ginger powder required amount of water was added to make ginger paste and pH 4.00 was adjusted by adding 0.5% citric acid. After adding sodium benzoate as preservative the paste samples were packed using low density polythene bags & air tight plastic container and stored at room temperature (25-30^{0}C) and refrigeration temperature (4-6^{0}C). Sample analysis for quality evaluation was done in 60, 120 and 180 days of storage.

Shelf life study of ginger powder and ginger paste

The samples of ginger powder and ginger paste were packed manually in two types of polyethylene bags. Ginger powder and ginger paste of 100g was filled in each package. There were 10 packs for each sample including replications while the total number of packs was 30. All the packages were quickly sealed using an electric impulse hand sealer and then the samples of ginger powder and ginger paste were stored at room temperature 25-30^{0}C on a laboratory shelf and another set of sample of ginger paste were stored at refrigerator maintaining a temperature of 4-6^{0}C. In case of room temperature all the sample packages were kept under shade to prevent from any effect of direct sunlight and other sources of heat. Each sample was drawn at 30 days interval for observation. And shelf life evaluation of was done simply by physical observation of its color, texture, flavor and moisture absorption. During the observation the researcher would either tick (√) or Cross (x) the evaluation sheet for indicating acceptable and non-acceptable condition of samples, respectively. The highest storage life of ginger powder and ginger paste was considered as the time of storage having no significant changes of its physical properties of color, texture, flavor and moisture absorption.

Proximate analysis

The moisture, ash, fat and protein content and acidity of the ginger powder and paste were determined by AOAC (2004) method.

Determination of Vitamin-C content

Ascorbic acid was determined by following the method of Ranganna (1991) with some modifications. 10g of the ginger sample was taken, diluted up to 100 ml with 3% HPO_3 and then filtered. 10 ml of the aliquot was taken in a 150 ml conical flask. 1 ml of 40% formaldehyde and 0.1 ml of HCl were added to it and kept for 10 minutes. This was titrated with the standard dye to a light pink color (end point), which persists for 15 seconds.

Calculation

$$mg\ of\ ascorbic\ acid\ per\ 100\ ml = \frac{\textbf{Titre} \times \textbf{Dye factor} \times \textbf{Vol. made up} \times \textbf{100}}{\textbf{Aliquot of extract} \times \textbf{wt. or vol. of the sample}}$$

Determination of carbohydrate content

Total carbohydrate contents of samples were calculated by difference, that the percentage of moisture, protein, fat and ash was subtracted from 100 (Pearson 1976).

Quality and sensory evaluation of ginger powder and paste

A panel consisting 10 experts taste panelists evaluated the color, taste, flavor and overall acceptability of ginger powder and ginger paste (Tummala *et al.,* 2008). Scores were given by the taste panelists according to the color, taste, flavor and overall acceptability based on their preferences. The sensory evaluation of the ginger powder and ginger paste were carried out by preparing two common food products namely beef curry and table sauces using the same amount of other normal spices in each. Each item was provided to a judge panel having 10 experts in order to carry out the sensory evaluation. The panelists mixed the samples with cooked rice and evaluated. Evaluation was done at the beginning and at the end after 3 months of storage of the samples. A hedonic scale having a maximum score of 9 for 'like extremely' and minimum of 1 for 'dislike extremely' was used to note the scores. The hedonic rating test in a scale of 1-9 marking was given as follows: Like extremely (9), like very much (8), like moderately (7), like slightly (6), neither like nor dislike (5), dislike slightly (4), dislike moderately (3), dislike very much (2), and dislike extremely (1).

Statistical analysis

All the means of the values and standard deviations from the obtained data were calculated and statistically analyzed using MSTAST-C. Meanwhile Duncan's Multiple Range Test was employed to determine the differences among different samples.

RESULTS AND DISCUSSION

The shelf life of ginger powder and ginger paste

From this study, the results of shelf life in terms of color, flavor and texture of ginger powder and ginger paste are presented in table-1, Table-2 and Table-3. Ginger powder exhibited acceptable shelf life in both types of packages up to 120 days, but stored in HDPE pouches showed the highest stability up to 180 days at room temperature. This might be because of packaging materials having less permeability. On the other hand ginger paste exhibited shelf life in both types of package up to 60 days when stored at room temperature but storage in refrigeration temperature it showed stability of color, flavor and texture up to 90 days in both types of packaging materials. However, a satisfactory shelf life of ginger paste was observed in HDPE up to 120 days. This might be because of packaging materials having less permeability of moisture during storage at refrigeration temperature. It found that HDPE pouches were best in respect of color, flavor and texture than LDPE bags. Using HDPE pouches ginger powder can be stored for more than 6 months safely. In case of ginger paste, the properties of color, flavor and texture were more stable when stored in refrigeration condition than room temperature. The rapid change of color, flavor and texture was in LDPE pouches due to absorption of moisture during both storage conditions.

Table 1. Shelf life of ginger powder in LDPE and HDPE at room temperature

Quality Attributes	Storage periods (Days)											
	30		60		90		120		150		180	
	LDPE	HDPE	LDPE	HDPE	LDPE	HDPE	LDPE	HDPE	LDPE	HDPE	LDPE	HDPE
Color	√	√	√	√	√	√	√	√	√	√	√	√
Flavor	√	√	√	√	√	√	√	√	x	√	X	√
Texture	√	√	√	√	√	√	√	v	x	√	X	√

'√' and 'X' indicates the acceptability and non-acceptability of the sample respectively in both LDPE and HDPE pouches during the storage period. LDPE = Low density polyethylene, HDPE = High density polyethylene

Table 2. Shelf life of ginger paste in LDPE and HDPE at room temperature

Quality Attributes	Storage periods (Days)											
	30		60		90		120		150		180	
	LDPE	HDPE	LDPE	HDPE	LDPE	HDPE	LDPE	HDPE	LDPE	HDPE	LDPE	HDPE
Color	√	√	√	√	√	√	X	X	X	X	X	X
Flavor	√	√	√	√	√	√	X	X	X	X	X	X
Texture	√	√	√	√	√	√	X	X	X	X	X	X

'√' and 'X' indicates the acceptability and non-acceptability of the sample respectively in both LDPE and HDPE pouches during the storage period. LDPE = Low density polyethylene, HDPE = High density polyethylene

Table 3. Shelf life of ginger paste in LDPE and HDPE at Refrigeration temperature

Quality Attributes	Storage periods (Days)											
	30		60		90		120		150		180	
	LDPE	HDPE	LDPE	HDPE	LDPE	HDPE	LDPE	HDPE	LDPE	HDPE	LDPE	HDPE
Color	√	√	√	√	√	√	X	√	X	x	X	x
Flavor	√	√	√	√	√	√	X	√	X	X	X	X
Texture	√	√	√	√	√	√	X	√	X	X	X	X

'√' and 'X' indicates the acceptability and non-acceptability of the sample respectively in both LDPE and HDPE pouches during the storage period. LDPE = Low density polyethylene, HDPE = High density polyethylene

Proximate composition of fresh ginger, ginger powder and ginger paste

The fresh ginger, ginger powder and ginger paste were analyzed and their chemical compositions are shown in Table-4.

Table 4. Chemical Composition of fresh ginger, ginger powder and ginger paste

Sample name	Proximate analysis							Vitamin-C (mg/100gm)
	Moisture (%)	Protein (%)	Fat (%)	Ash (%)	Carbohydrate (%)	pH	Acidity (%)	
Fresh ginger	78.67±0.76[b]	1.62±0.11[b]	1.3±0.06[a]	1.00±0.07[b]	17.27±1.18[b]	6.15±0.13[a]	0.16±0.02	6.33±1.0[a]
Ginger powder	6.30±0.39[c]	4.17±0.30[a]	0.99±0.08[a]	4.13±0.38[a]	84.35±0.65[a]	5.53±0.39[b]	0.11±0.01	0.77±0.05[b]
Ginger paste	84.52±1.35[a]	0.93±0.02[c]	0.34±0.24[b]	0.75±0.03[c]	13.59±0.46[c]	4.02±0.12[c]	0.17±0.04	5.24±0.14[a]

All values are expressed as mean ±SD
Mean followed by different superscript letters in each column are significantly different ($p<0.05$)

From table-4, the ginger powder contained moisture 6.30%, protein 4.17%, fat 0.99%, ash 4.13%, carbohydrate 84.35%, pH 5.53, acidity 0.11% and vitamin C 0.77mg/100gm of ginger powder. The values are slightly similar to those found by Leung (1972) and Pruthi (2000) who reported that the dried ginger content 6.9% moisture, 5.00% ash, 8.1% protein, 0.98% fat and 66.8% carbohydrate. There was a decreasing trend to the fat content of ginger powder which might be happened due to oxidation.

The ginger paste contained moisture 84.52%, protein 0.93%, fat 0.34%, ash 0.75%, carbohydrate 13.59%, pH 4.02, acidity 0.17%, vitamin-C 5.24mg/100gm of ginger paste. On the other hand the fresh ginger contained moisture 78.67%, protein 1.62%, fat 1.3%, ash 1.0%, carbohydrate 17.27%, pH 6.15, acidity 0.16%, vitamin-C 76.33mg/100gm of fresh ginger. The composition of this fresh ginger under this study was more or less similar to those reported by Leung (1972), who reported that the composition of ginger contained moisture 87.4%, protein 1.6%, fat 0.8%, ash 1.0%, carbohydrate 9.2%, vitamin-C 4.0mg/100gm of ginger; energy 46 calories; carbohydrate 9.2%, calcium 19.00mg and phosphorus 32.0 mg. It was observed that the moisture content was increased while others composition were decreased in ginger paste due to different treatments like blanching, crushing and addition of water significantly affected. The composition of ginger may vary due to process unit operations and temperature.

Changes in chemical composition during Storage Period

The effect of temperature and storage time on the composition of ginger paste packed in low density polyethylene (LDPE) bags and high density polyethylene (HDPE) bags in the room temperature and refrigeration temperature had studied. For ginger powder the samples were stored in same packaging materials and maintained only room temperature.

Changes in chemical composition of ginger powder during storage period

The prepared ginger powder was analyzed for moisture, ash, protein, fat, pH and vitamin-C at the 60 days interval. The total study life was 180 days. The results were shown in table-5.

Table 5. The effects of temperature, storage time and packaging materials on the composition of ginger powder at room temperature

Chemical Composition	Processing Day	Packaging materials: LDPE, Storage Days 60	LDPE 120	LDPE 180	HDPE 60	HDPE 120	HDPE 180
Moisture (%)	6.30±0.39[c]	7.673±0.44[d]	8.847±0.11[b]	9.503±0.36[a]	6.690±0.36[e]	7.793±0.18[cd]	8.263±0.26[c]
Ash (%)	4.13±0.38[a]	3.670±0.35[c]	3.913±0.04[ab]	3.857±0.13[d]	3.993±0.09[a]	3.90±0.07[b]	3.70±0.61[d]
Vitamin C (mg/100gm)	0.77±0.05[b]	0.440±0.09[b]	0.123±0.01[d]	0.067±0.01[d]	0.580±0.04[a]	0.313±0.02[c]	0.107±0.01[d]
pH	5.53±0.39[b]	5.603±0.32[c]	5.873±0.06[b]	5.877±0.05[b]	5.827±0.07[bc]	5.680±0.41[c]	5.627±0.52[c]

All values are expressed as mean ±SD
Mean followed by different superscript letters in each column are significantly different ($p<0.05$)
LDPE = Low density polyethylene, HDPE = High density polyethylene

From the table-5, it is shown that the moisture content of the ginger powder in low density polyethylene (LDPE) bags were 6.30%, 7.673%, 8.847% and 9.503% at processing day, 60, 120 and 180 days of storage, respectively. On the other hand, the moisture content of the samples in high density polyethylene (HDPE) bags were 6.75%, 6.690%, 7.793%, and 8.263% at processing day, 60, 120 and 180 days of storage, respectively. It is observed that the moisture content gradually increased due to water vapor transmission through polyethylene bag and the rate is high in case of LDPE than HDPE bags. The ash content of ginger powder were 4.13%, 3.670%, 3.913%, and 3.857% in low density polyethylene bags at processing day, 60, 120 and 180 days of storage, respectively while in case of HDPE bags Ash contents were 4.13%, 3.993%, 3.90% and 3.870% at processing day, 60, 120 and 180 days of storage, respectively.

It was observed that the vitamin-C was reduced as storage time increased. The vitamin-C of ginger powder was 0.77mg/100gm at processing day. After 180 days of storage vitamin-C of ginger powder was found 0.067mg/100gm in LDPE bag. Moreover, Vitamin-C in ginger powder in HDPE bag was 0.107mg/100gm after 180 days. The pH of the ginger powder in both LDPE and HDPE bags were slightly increased at each observation period which was stored in room temperature. From table-5, it was observed that the moisture content of ginger powder had increased in both types of packages. The ash content and vitamin-C were gradually decreased. But the pH of the sample was increased due to decreasing of acidity in Storage period.

Changes in chemical composition of ginger paste during storage period

The prepared ginger paste was packaged in LDPE and HDPE bags and stored in both room temperature and refrigeration temperature. At 60 days of interval, the samples were analyzed for moisture, ash, protein, fat, acidity, pH and vitamin-C. The total study life was 180 days. The results were shown in table-6 and table-7.

Table 6. The effects of temperature, storage time and packaging materials on the composition of ginger paste at room temperature

Chemical Composition	Processing Day	Packaging materials: LDPE, Storage Days 60	LDPE 120	LDPE 180	HDPE 60	HDPE 120	HDPE 180
Moisture (%)	84.52±1.35[a]	82.897±0.40[ab]	82.117±0.17[ab]	81.083±1.06[ab]	83.130±0.37[ab]	81.713±2.41[ab]	81.540±1.53[ab]
Ash (%)	0.75±0.03[c]	0.797±0.14[b]	0.823±0.03[abc]	0.887±0.04[a]	0.787±0.01[abc]	0.807±0.02[abc]	0.857±0.01[ab]
Vitamin-C (mg/100gm)	5.24±0.14[a]	4.523±0.03[a]	2.10±0.06[cde]	1.12±0.11[de]	4.807±0.22[a]	2.483±0.37[bc]	1.292±0.15[c]
pH	4.02±0.12[c]	4.457±0.40[cd]	5.103±0.01[ab]	5.30±0.26[a]	4.30±0.09[d]	5.030±0.06[ab]	5.320±0.29[a]

All values are expressed as mean ±SD
Mean followed by different superscript letters in each column are significantly different ($p<0.05$)
LDPE = Low density polyethylene, HDPE = High density polyethylene

From table-6 and table-7, the moisture content of ginger paste was slightly reduced during different storage conditions. The initial moisture content 84.52% was found in all samples. After 180 days of storage, the moisture content in LDPE bags & HDPE bags were 81.083% & 81.540% in room temperature. On the other hand, the moisture content in LDPE bags & HDPE bags were 82.260% & 82.667%, respectively in refrigeration temperature. The decrease of moisture content with LDPE bags in room temperature may occur due to moisture migration to atmosphere than the refrigeration temperature with HDPE bags.

The initial ash content of 0.75% was found in all samples. After 180 days of storage, the ash content in LDPE bags & HDPE bags were 0.887% & 0.857% in room temperature, respectively when the ash content in LDPE bags & HDPE bags were 0.828% & 0.805%, respectively in refrigeration temperature.

It was observed that the vitamin-C of ginger paste was 5.24 mg/100gm in the processing day. Vitamin-C was gradually decreased with the increasing of storage time. After 180 days of storage, vitamin-C of ginger paste was 1.12mg/100gm in LDPE bags and 1.29mg/100gm in HDPE bags at room temperature. But in the refrigeration temperature, the vitamin-C was 0.820mg/100gm in LDPE bags & 0.973mg/100gm in HDPE bags. Thus it was observed that vitamin-C of ginger paste in HDPE was slightly higher in refrigeration temperature than stored in room temperature.

The pH of ginger paste (Table-7) was 4.02 in the processing day. But the pH of ginger paste was slightly increased at each observation period for samples stored at both room temperature and refrigeration temperature. The slightly increase in pH of ginger paste may be due to reduction of acidity with the increase of storage period.

Table 7. The effects of temperature, storage time and packaging materials on the composition of ginger paste at refrigeration temperature

Chemical Composition	Processing Day	Packaging materials					
		LDPE			HDPE		
		Storage Days					
		60	120	180	60	120	180
Moisture (%)	$84.52{\pm}1.35^{a}$	$79.90{\pm}6.01^{b}$	$82.980{\pm}0.87^{ab}$	$82.260{\pm}0.43^{b}$	$83.130{\pm}0.62^{ab}$	$83.13{\pm}0.14$	$82.667{\pm}0.51^{ab}$
Ash (%)	$0.75{\pm}0.03^{c}$	$0.750{\pm}0.03^{c}$	$0.793{\pm}0.01^{b}$	$0.828{\pm}0.01^{ab}$	$0.747{\pm}0.02^{c}$	$0.779{\pm}0.01^{b}$	$0.805{\pm}0.01^{ab}$
Vitamin-C (mg/100gm)	$5.24{\pm}0.14^{a}$	$4.290{\pm}0.18^{a}$	$2.777{\pm}0.19^{bc}$	$0.820{\pm}0.01^{e}$	$4.215{\pm}0.21^{a}$	$2.629{\pm}0.16^{ab}$	$0.973{\pm}0.01^{c}$
pH	$4.02{\pm}0.12^{c}$	$4.223{\pm}0.2^{d}$	$4.727{\pm}0.34^{bc}$	$5.067{\pm}0.05^{ab}$	$4.378{\pm}0.05^{b}$	$4.807{\pm}0.15^{bc}$	$5.060{\pm}0.07^{ab}$

All values are expressed as mean ±SD
Mean followed by different superscript letters in each column are significantly different ($p<0.05$)
LDPE = Low density polyethylene, HDPE = High density polyethylene

Statistical sensory evaluation of ginger powder and paste

The processed product of ginger powder and paste were subjected to sensory evaluation by a panel of 10 experts. The mean scores for color, flavor, texture and overall acceptability of the ginger products are represented in table-8. The evaluation were conducted after 90 days of storage since most of the samples remained in good condition during this period.

Table 8. Mean sensory scores of ginger products after 90 days storage

Sample	*Mean scores of sensory attributes			
	Color	Flavor	Texture	Overall acceptability
Sample-A	$8.2{\pm}0.48^{a}$	$8.1{\pm}0.46^{b}$	$8.0{\pm}0.44^{b}$	$8.1{\pm}0.43^{b}$
Sample-B	$8.8{\pm}0.70^{a}$	$8.9{\pm}0.80^{a}$	$8.8{\pm}0.72^{a}$	$8.8{\pm}0.65^{a}$
Sample-C	$6.0{\pm}0.45^{d}$	$5.0{\pm}0.34^{e}$	$5.1{\pm}0.52^{e}$	$5.7{\pm}0.24^{d}$
Sample-D	$6.8{\pm}0.47^{c}$	$5.9{\pm}0.17^{d}$	$5.9{\pm}0.20^{d}$	$6.1{\pm}0.28^{d}$
Sample-E	$7.5{\pm}0.55^{b}$	$6.8{\pm}0.60^{c}$	$6.8{\pm}0.18^{c}$	$7.1{\pm}0.32^{c}$
Sample-F	$7.2{\pm}0.46^{bc}$	$7.3{\pm}0.16^{c}$	$7.5{\pm}0.43^{b}$	$7.6{\pm}0.29^{bc}$
LSD ($p<0.05$)	0.618	0.626	0.687	0.690

All values are expressed as mean ±SD
Mean followed by different superscript letters in each column are significantly different ($p<0.05$)
Sample-A: Ginger powder stored at low density polyethylene bag in room temperature, Sample-B: Ginger powder stored at high density polyethylene in room temperature, Sample-C: Ginger paste stored at low density polyethylene bag in room temperature, Sample-D: Ginger paste stored at high density polyethylene bag in room temperature, Sample-E: Ginger paste stored at low density polyethylene bag in refrigeration temperature, Sample-F: Ginger paste stored at high density polyethylene bag in refrigeration temperature

From table-8, a single way analysis of variance (ANOVA) was carried out and significant ($p<0.05$) difference was found. The DMRT test revealed that the treatment of ginger product with different packaging materials and storage condition significantly affected the degree of color acceptability of the ginger powder and paste. The highest color score was achieved with the sample-B that was score 8.8; while the lowest score (6.0) was sample-C. The color of the Sample-B was approximately similar of sample-A.

In case of flavor preference among the ginger powder and paste of single way analysis of variance (ANOVA) showed that the samples were significantly affected in flavor acceptability. It has been revealed by DMRT test that the treatments of the ginger products with different storage condition and packaging significantly affected the degree of flavor acceptability of the ginger products. The highest flavor score (8.9 out of 9.0) was achieved with the sample-B which was ginger powder that packaged at high density polythene bags. While the lowest score (5.0 out of 9.0) was found sample-C which was ginger paste and packaged in low density polythene bag at normal room temperature. It was shown in table-8, texture preferences among the ginger powder and paste of single way analysis of variance (ANOVA) showed that the samples were significantly affected in texture acceptability. DMRT test showed that the treatments of the ginger products with different storage conditions and packaging significantly affected the degree of texture acceptability of the ginger products. The highest flavor score (8.8 out of 9.0) was achieved with the sample-B which was ginger powder that packaged at high density polythene bags. While the lowest score (5.1 out of 9.0) was found sample-C which was ginger paste and packaged in low density polythene bags at room temperature.

It was apparent from the results of the ANOVA, the DMRT test revealed that the overall acceptability of the ginger powder that packaged in low density polythene bags and high density polyethylene bags were more acceptable than ginger paste. Moreover ginger paste which stored in refrigeration temperature was more acceptable than ginger paste that was stored in room temperature.

CONCLUSION

In this study the changes in nutritional quality due to different processing techniques in terms of proximate composition along with sensory preferences and shelf life of ginger powder and ginger paste were investigated. The study revealed that both samples ginger powder and ginger paste stored in room temperature and refrigeration temperature were found to be better in terms of shelf life, acceptable sensory preferences as well as with nutritional values when it was stored using high density polyethylene (HDPE) bags. The ginger powder and ginger paste can be used as spice in order to enhance the taste along with the nutritional quality of food products. The findings of the present study may help in developing commercial processing technology of ginger powder and paste for effective utilization by improving storage condition and a potential technique to minimize post harvest losses of ginger in Bangladesh.

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