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Research Article

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Packaging Effect on the Quality and Storage Stability of Processed Ginger Paste

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Abstract The effect of packaging of processed ginger paste was investigated to determine the paste quality and storage life during stored at room temperature. The experiment was carried out using Completely Randomized Design and there were ten treatments combination using two different packaging materials and five different salt concentrations. The paste was stored for four months and each month interval physico-chemical and external color parameters were analyzed. The analysis was done under computerized statistical methods of M-stat and Duncan's Multiple Range Test was used to compare the means. The acidity contents of the processed ginger paste were decreased and p^H contents were increased after increased the storage life of the products within different salt percentages. The paste was kept and stored up to 4 months in glass container gives little changed in TSS and dry matter percentages. The intensity of light yellow color of the ginger paste were gradually increased with extend the storage period and turned yellow as evidence by increasing values of lightness and changing values of chroma and hue angle accordingly. The ginger paste treated with salt, pour in glass container and stored at room temperature of 25 to 30 ºC had no presence of bacteria up to 4 months.

Keywords Ginger paste; Packaging; Quality; Storage stability; Microbial growth

1. Introduction

Ginger is the botanically known as *Zingiber officinale* Rose. Ginger is an important spice of Bangladesh locally called as 'Ada'. It is an originated in Southeast Asia [1]. Ginger has been considered as important traditional herbal medicine due to their disease prevention effects. 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 [2]. Other important producers are china, Nepal, Thailand, Nigeria and Indonesia. In Bangladesh, ginger grows well in Rangpur, Nilphamari, Khulna, Rangamati, Bandharban and Khagra- Chori, districts. The total area of cultivation and the annual production of ginger were 8906.88 ha and 80,000 metric tons, respectively [3]. On the other hand, the total area of cultivation and annual production were 9068.83 ha and 78,841 metric tons respectively [2].

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 postharvest losses. If spoilage/postharvest losses could be reduced to an acceptable level by proper preservation, farmers would get more prices of their products and thus be encouraged to increase the yield as well as total production. As in developed countries of Bangladesh, still we cannot use high technology, sophisticated machineries or equipment, skilled men power and large capital investment for modern food

processing industries. 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.

Ginger paste is a viscous product retaining the strong aroma and flavor of raw materials. Fresh ginger paste is mainly used as a spice in culinary preparations for imparting a characteristic fresh ginger favor. The product is generally light yellow in color and is microbiologically stable and free from pathogenic bacteria. The paste, as a convenient 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 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. Spice paste would help to prepare our food easily and hence the present research was undertaken to find out the appropriate packaging techniques on the quality and storage stability of processed ginger paste when it was stored at room temperature of 25 to 30 ºC.

2. Materials and Methods

The experiments were conducting in the Postharvest Technology Division of Bangladesh Agricultural Research Institute, Gazipur in the year of 2015-2016.

2.1. Raw Material

Good quality ginger rhizomes (BARI ginger-1) were collected form Spices Research Centre and used in this study for further analysis.

2.2. Preparation of Ginger Paste

The ginger rhizomes were broken into pieces to expose the crevices and then washed in running water to remove the adhering mud. Again, the cleaned rhizomes were scraped with a knife to remove dirt as well as spoiled portion. The ginger rhizomes were peeled and make paste using grinder then hold at room temperature for 1 hr in covered container to facilitate enzymatic action for flavor and color development. The pastes were treated with 0%, 3%, 6%, 9%, and 12% common salt and added citric acid 0.4%. Using different percentages of common salt, the pH level of the paste was come down and adjusted around 4.0. The paste were thermally processed at 100 ºC for 20 min in water bath and poured immediately in glass bottle and plastic container according to the treatments used in the study. Then, the processed paste with containers was stored at room temperature (25 to 30 ºC). The physic-chemical parameters and microbial test were carried out to examine the quality and shelf life of the paste was studied during storage.

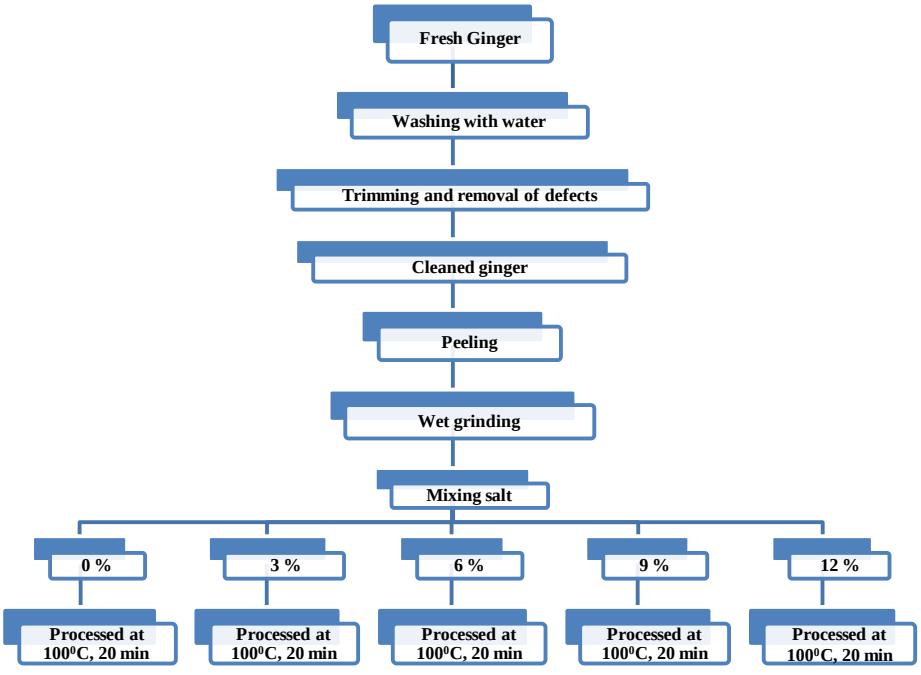

Figure 1: Flow Chart of Ginger Paste Preparation

Treatments

T_1, T_3, T_5, T_7 and T_9 =ginger paste in glass (G) container in 0%, 3%, 6%, 9%, 12% salt, respectively

T_2, T_4, T_6, T_8 and T_{10} = ginger paste in plastic (P) container in 0%, 3%, 6%, 9%, 12% salt, respectively

2.3. Measurement of titratable acidity, pH and total soluble solids (TSS)

Titratable acidity in the processed paste was measured in terms of citric acid following the method described by Wang *e t al*. [4]. For measuring titratable acidity, 5 g paste were diluted with 95 mL distilled water making the volume to100 mL, then filtered through Whatman no. 41 filter paper and titrated against 0.1 N NaOH to P^H 8.1 using phenolphthalein indicator. Acidity was expressed as percent citric acid by weight. The paste sample (5 g) was diluted with 45 mL distilled water, and P^H was measured with glass electrode (EUTECH Instruments, Selangor, Malaysia). Sodium chloride was determined by titration with silver nitrate [5].

Total soluble solids (°Brix) were determined with a digital bench top Abbe Refractometer at 20 ºC (Atago Co., Ltd., Tokyo, Japan). To determine the total soluble solids, the paste was dried under vacuum at 70 ºC to constant weight. The dried samples were allowed to cool in desiccators for 30 min and then weighed [6].

Total solids (%) = (mass of dried sample mass/mass of fresh sample) ×100.

2.4. Measurement of Color

Color measurement was done by the method of Hunt [7]. Ginger–garlic paste color was measured and compared using a Hunter colorimeter model "Lab scan XE" (Hunter Associates Laboratory, Reston, VA) using universal software, based on three color coordinates namely L, a, and b. The instrument is calibrated using a standard white (L = 90.70, a = -1.08. b = 0.65) and blank reference tile under illuminated conditions such as "C" illumination and via angle 2°. The color values given by L, a, b is generally expressed as total color of the sample. "L" represents the lightness index, "a" represents red-green, whereas "b" represents yellow-blue color components.

2.5. Microbiological Analysis

Enumeration of coliforms, mesophilic aerobes and yeasts and molds were done by pour plate and spread plate method following the procedure of the International Commission on Microbiological Specifications [8]. Violet red bile agar for coliform bacteria, plate count agar (PCA) for mesophilic aerobes and potato dextrose agar (PDA) for yeast and molds procured from Himedia, India were used. Ten grams of ginger garlic paste sample were weighed in duplicates into 90 mL of 0.1% peptone water aseptically, homogenized and serial dilution was carried out. One milliliter of the appropriate dilution of the sample was taken in sterile Petri plates and 15 mL of respective agar maintained at 45 ºC were poured into plates and allowed to solidify. Set plates were incubated at 37 ºC for 48 h and colony count was taken after 24–48 h of incubation for bacteria. The potato dextrose plates for yeasts and molds were incubated at 27 ºC for 3–4 days and colony count was recorded. All tests were carried out in duplicate and the average mean values are reported.

2.6. Statistical Analysis

The experiment was carried out Completely Randomized Design (CRD) and all ten treatments were replicated three times. Statistical analysis was done under computerized statistical methods of M-stat for each treatment. It was carried out by analysis of variance followed by Duncan's new multiple range test [9] to found out differences between treatments at the probability level of P <0.05.

3. Results and Discussion

The process ginger paste was stored at room temperature of 25 to 30 ºC for four months in the year of 2015-2016. The experiment was conducted and data were analyzed. The interactive results are shown in the following sections.

3.1. Individual effects of packaging materials, salt percentages and duration of storage

The individual effects of packaging materials, salt percentages and duration of storage on the physico-chemical and external color parameters of processed ginger paste are shown in Table 1. The effects of packaging materials sequences had non-significant (NS) effects on the quality parameters of ginger paste, which are shown in Table 1(a). The highest TSS, pH and acidity values were found in glass container (G) as compared to the paste was stored in plastic container (P), although the products of both containers were found bright in color and

high intensity. The paste was stored at room temperature of 25 to 30 ºC; the hue angle (H) was turning into orange to yellow. There were no significant differences in dry matter content in both glass and plastic container.

The effects of salt percentages (S) on the quality parameters of ginger paste are presented in Table 1 (b). During different percentages of salt added in the processed ginger paste, the P^H level was adjusted and come down around 4.0 adding citric acid into the paste. The highest TSS, acidity, dry matter percentages, lightness, chroma and hue angle but lowest P^H values were found using 12% salt added in the paste, whereas, the values were decreased using 9%, 6% and 3% salt added as compared to 12%, respectively.

The effects of duration of storage (D) on the quality parameters of ginger paste as shown in Table 1 (c). The highest values of TSS, PH and hue angle were found after 4 months storage; whereas, the lowest values of dry matter percentage, lightness and chroma were observed in the same duration. The comparisons of all the parameters, the paste was found best condition after 3 months storage at room temperature of 25 to 30^0C condition.

Table 1: Individual effects of packaging materials, salt percentages and duration of storage on the physico-chemical and external color parameters of processed ginger paste

(a) Effect of packaging materials

Treatments	TSS (%)	pH	Acidity (%)	DM (%)	Lightness	Chroma	Hue angle
Glass container (G)	11.76	4.81	0.34	24.33	55.46	24.67	82.88
Plastic container (P)	11.60	4.77	0.33	24.44	56.21	24.41	83.39
CV%	0.86	2.09	3.01	0.50	0.32	0.41	2.13
LSD	NS						

(b) Effect of salt percentages (S)

Treatments	TSS (%)	pH	Acidity (%)	DM (%)	Lightness	Chroma	Hue angle
T_1& T_2 (S_1= 0% salt)	5.47e	7.19a	0.12d	18.94e	43.71e	18.48e	74.83e
T_3& T_4 (S_2= 3% salt)	7.61d	4.27b	0.30c	23.14d	49.49d	24.40d	82.51d
T_5& T_6 (S_3= 6% salt)	12.23c	4.20c	0.37b	24.25c	56.60c	25.21c	84.95c
T_7& T_8 (S_3= 9% salt)	14.72b	4.16cd	0.43a	27.28b	61.70b	26.25b	86.09b
T_9& T_{10} (S_5= 12% salt)	18.36a	4.13d	0.47a	28.30a	67.77a	28.36a	87.28a
CV%	0.86	2.09	3.01	0.50	0.32	0.41	2.13
LSD	0.051	0.051	0.051	0.063	0.093	0.051	0.91

(c) Effect of duration of storage (D)

Duration of storage (D)	TSS (%)	pH	Acidity (%)	DM (%)	Lightness	Chroma	Hue angle
D_1= 0 month	11.48d	4.65d	0.38a	25.31a	60.96a	22.88d	79.90e
D_2= 1 month	11.52d	4.70d	0.34ab	24.91b	58.43b	24.16c	80.88d
D_3= 2 month	11.67c	4.80c	0.33ab	24.33c	55.51c	26.01b	83.74c
D_4= 3 month	11.77b	4.86b	0.32b	23.89d	53.76d	27.54a	84.96b
D_5= 4 month	11.95a	4.94a	0.30b	23.47e	50.51e	22.10e	86.18a
CV%	0.86	2.09	3.01	0.50	0.32	0.41	2.13
LSD	0.051	0.051	0.051	0.068	0.093	0.051	0.91

Means in the same column followed by different letters differs (P<0.05) according to the least significant difference multiple range test

3.2. Combined effect of packaging materials, salt percentages and duration of storage

The interactive effects of packaging materials and salt percentages added in the paste on the quality parameters of ginger paste are depicted in Table 2. The highest values of TSS, acidity, dry matter percentages, lightness, chroma and hue angle were obtained from the interaction between glass container and 12% salt added in the paste, where the P^H was low. In all the interactions were varied almost in the same fashion depends on the effects of container and salt percentages added in the paste. Most of the cases, within one month storage the presence of bacteria and others microbial growth was seen in processed ginger paste at plastic container are

presented in Table 6. This interactive result found that the processed ginger paste was stored in glass container and added 12% salt was suitable.

Table 2: Combined effect of packaging materials (G & P) and salt percentages (S) on the physico-chemical and external color parameters of processed ginger paste

Treatments	TSS (%)	pH	Acidity (%)	DM (%)	Lightness	Chroma	Hue angle
GS_1	6.14h	7.25a	0.12d	18.84h	43.06j	18.57i	74.38e
GS_2	7.82f	4.29c	0.31c	23.12f	48.64h	24.47g	82.56d
GS_3	12.10e	4.21cde	0.37bc	24.20e	56.44f	25.31e	84.10c
GS_4	14.36c	4.18de	0.44ab	27.23c	61.56d	26.40c	86.09ab
GS_5	18.38a	4.13e	0.47a	28.34a	67.95a	28.57a	87.30a
PS_1	4.80i	7.15b	o.11d	19.04g	44.36i	18.39j	75.28e
PS_2	7.40g	4.25cd	0.30c	23.15f	50.15g	24.32h	82.46d
PS_3	12.36d	4.19de	0.37bc	24.30d	56.77e	25.11f	85.80b
PS_4	15.08b	4.14e	0.43ab	27.34b	61.83c	26.10d	86.09ab
PS_5	18.34a	4.13e	0.46a	28.25a	67.59b	28.15b	87.25a
CV%	0.86	2.09	3.01	0.50	0.32	0.41	2.13
LSD	0.072	0.072	0.072	0.089	0.132	0.072	1.29

Note: G= Glass container; P= Plastic container

Means in the same column followed by different letters differs (P<0.05) according to the least significant difference multiple range test

The interactive effects of packaging materials and duration of storage on the quality parameters of ginger paste are given in Table 3. Although, the highest values of P^H, acidity, dry matter percentages and lightness were found at using plastic container but the quality of the processed ginger paste was not suitable (shown in table 6) due to off-flavor on the growth of bacteria and other microbes on it. Considering the paste quality, glass container has suitable packaging materials and the shelf life results seen best after 2 months of storage among the other storage periods. This interactive result seen that the processed ginger paste was stored up to 2 months in glass container at room temperature of 25 to 30 ºC condition.

Table 3: Combined effect of packaging materials (G & P) and duration of storage (D) on the physico-chemical and external color parameters of processed ginger paste

Treatments	TSS (%)	pH	Acidity (%)	DM (%)	Lightness	Chroma	Hue angle
GD_1	11.60b	4.83f	0.31a	23.91b	54.27b	27.31a	85.21b
GD_2	11.94a	4.93e	0.30a	23.44c	50.96d	22.09e	86.69a
GD_3	11.32c	4.78g	0.29a	23.21c	51.52d	21.92f	83.62c
GD_4	6.65g	6.89d	0.13b	19.16e	46.63f	15.51i	70.86g
GD_5	5.10h	7.15c	0.12b	19.12e	42.94g	19.58h	76.15f
PD_1	4.35i	7.40b	0.11b	18.58f	41.38h	21.82g	79.08e
PD_2	3.55j	7.70a	0.01b	18.56f	37.85i	22.30d	81.52d
PD_3	7.10f	4.17i	0.36a	24.15a	55.12a	21.89f	80.44d
PD_4	7.50e	4.19i	0.32a	23.83b	54.03c	23.62c	78.34e
PD_5	7.70d	4.30h	0.29a	22.72b	49.10e	26.20b	83.51c
CV%	0.86	2.09	3.01	0.50	0.32	0.41	2.13
LSD	0.072	0.072	0.072	0.089	0.132	0.072	1.29

Means in the same column followed by different letters differs (P<0.05) according to the least significant difference multiple range test

The interactive effects of different salt percentages added in the paste and duration of storage on the quality parameters of ginger paste as shown in Table 4. Among the all interactions, the highest values of TSS, chroma and hue angle were seen using 12% salt added in the processed ginger and it stored after 4 months; whereas, the values of P^H, acidity, dry matter percentages and lightness of the paste were given best performance on an added

12% salt with 2 months of storage period. This interactive result noticed that the processed ginger paste was stored up to 4 months with 12% salt gives the significant changes in the TSS, lightness, chroma and hue angle.

Table 4: Combined effect of salt percentages (S) and duration of storage (D) on the physico-chemical and external color parameters of processed ginger paste

Treatments	TSS (%)	pH	Acidity (%)	DM (%)	Lightness	Chroma	Hue angle
S_1D_1	7.70p	6.85d	0.15fg	19.30q	49.75q	27.31g	66.54n
S_1D_2	6.65s	6.89d	0.13g	19.16qr	46.63t	22.09op	70.86m
S_1D_3	5.10t	7.15c	0.12g	19.12r	42.94u	22.10op	76.15l
S_1D_4	4.35u	7.40b	0.11g	18.58s	41.38v	15.51s	79.08k
S_1D_5	3.55v	7.70a	0.10g	18.56s	37.85w	19.58r	81.52ij
S_2D_1	7.10r	4.17fghij	0.36bcde	24.12k	55.12m	21.82q	80.44jk
S_2D_2	7.15q	4.18fghij	0.32cde	23.83l	54.03o	22.30n	78.34k
S_2D_3	7.70p	4.30ef	0.29de	22.72n	49.10r	21.89q	83.51ghi
S_2D_4	7.85o	4.29efg	0.28e	22.57o	47.55s	23.62m	84.51efgh
S_2D_5	7.19o	4.40e	0.26ef	22.41p	41.17v	26.20j	85.75cdefg
S_3D_1	11.90n	4.14hij	0.42abcd	25.40i	61.33h	28.13d	82.85hi
S_3D_2	11.80n	4.15hij	0.40abcde	24.91j	58.03j	22.14o	83.76fgh
S_3D_3	12.15n	4.21fghi	0.37bcde	24.03k	55.80l	24.51l	85.08defgh
S_3D_4	12.55n	4.25fgh	0.35bcde	23.73l	54.88n	25.40k	85.99bcdef
S_3D_5	12.75k	4.26fgh	0.32cde	23.19m	52.97p	26.13j	87.08abcd
S_4D_1	13.40j	4.07jk	0.47ab	28.35c	66.94d	27.96e	83.92fgh
S_4D_2	14.05i	4.15hij	0.45abc	27.71d	63.94f	22.06op	85.06dfgh
S_4D_3	14.80h	4.17fghij	0.44abc	27.56e	61.33h	26.43i	86.47abcde
S_4D_4	15.30g	4.19fghij	0.42abcd	26.88g	59.10i	27.08h	86.96abcd
S_4D_5	16.05f	4.21fghi	0.40abcde	25.93h	57.17k	22.52f	88.02abc
S_5D_1	17.30e	4.00k	0.51a	29.36a	71.65a	28.19d	86.75cdefg
S_5D_2	17.60d	4.10ijk	0.49ab	28.95b	69.54b	22.01p	86.37abcde
S_5D_3	18.60c	4.16ghij	0.46ab	28.24c	68.39c	28.36c	87.47abc
S_5D_4	18.80b	4.19fghij	0.44abc	27.68de	65.89e	29.19b	88.27ab
S_5D_5	19.50a	4.20fghij	0.43abc	27.24f	63.38g	30.63a	88.53a
CV%	0.86	2.09	3.01	0.50	0.32	0.41	2.13
LSD	0.115	0.115	0.115	0.140	0.208	0.115	2.031

Means in the same column followed by different letters differs ($P<0.05$) according to the least significant difference multiple range test

The combined effects among the packaging materials, salt percentages and duration of storage on the quality parameters of ginger paste are shown in Table 5. In most of the cases, plastic container paste seen bad in condition due to growth in bacteria and other microbes on it not only longer period but also only after one month storage (Table 6). Using glass container with 12% salt, the TSS (19.50%) and hue angle (88.59) values were observed highest after 4 months of storage but the second highest values were observed after 3 months of storage; whereas the highest value of chroma (32.14) was found after 3 months and followed was after 2 months of storage. At control condition in glass container found lowest P^H (4.00), and the highest acidity (0.51), dry matter percentages (29.46) and lightness (71.65) were found but the paste were not suitable to storage due to spoilage at control condition. On the other hand, after 1 month of storage using same packaging material the second lowest P^H was 4.10, and the second highest acidity (0.49), dry matter percentages (29.04) and lightness (69.79) were found. There were little increase of P^H (4.20) and significant decreases of acidity (0.44), dry matter percentages (27.44) and lightness (63.76) were observed after 4 months of storage using glass container with 12% salt added in the paste at 25^0C control temperature condition. Among the all interactions, it was noticed that the processed ginger paste stored in glass container up to 4 months using 12% salt added at room temperature of 25 to 30 ºC condition.

Table 5: Combined effects among the packaging materials (G & P), salt percentages (S) and duration of storage (D) on the physico-chemical and external color parameters of processed ginger paste

Treatments	TSS (%)	P^H	Acidity (%)	DM (%)	Lightness	Chroma	Hue angle
GS_1D_1	7.80	6.85	0.15	19.20	49.75	13.21	66.54
GS_1D_2	7.30	6.90	0.13	19.01	45.75	15.05	70.02
GS_1D_3	6.00	7.20	0.12	18.90	42.53	20.31	76.33
GS_1D_4	5.40	7.50	0.11	18.56	40.41	21.97	78.95
GS_1D_5	4.20	7.80	0.10	18.54	36.45	22.32	80.04
GS_2D_1	7.10	4.20	0.36	24.05	55.12	21.89	79.15
GS_2D_2	7.80	4.20	0.32	23.89	53.32	23.81	80.36
GS_2D_3	8.00	4.34	0.23	22.68	48.09	26.31	83.33
GS_2D_4	8.10	4.30	0.29	22.56	46.54	28.19	84.01
GS_2D_5	8.10	4.40	0.270	22.40	40.12	22.17	85.46
GS_3D_1	11.90	4.15	0.42	25.30	61.33	24.51	81.77
GS_3D_2	11.70	4.16	0.40	24.85	57.71	25.48	82.90
GS_3D_3	12.20	4.22	0.37	24.01	55.52	26.26	84.11
GS_3D_4	12.30	4.26	0.35	23.70	54.75	28.24	85.36
GS_3D_5	12.40	4.27	0.30	23.15	52.89	22.07	86.36
GS_4D_1	13.40	4.10	0.47	28.19	66.94	26.43	83.92
GS_4D_2	13.20	4.18	0.45	27.65	63.65	27.32	85.06
GS_4D_3	14.50	4.18	0.44	27.54	61.02	27.89	86.47
GS_4D_4	15.10	4.20	0.42	26.85	58.76	28.34	86.96
GS_4D_5	15.60	4.22	0.40	25.90	57.45	22.01	88.02
GS_5D_1	17.30	4.00	0.51	29.46	71.65	28.36	85.75
GS_5D_2	17.70	4.10	0.49	29.04	69.79	29.28	86.54
GS_5D_3	18.60	4.15	0.47	28.45	68.56	31.08	87.55
GS_5D_4	18.80	4.20	0.45	27.70	65.76	32.14	88.31
GS_5D_5	19.50	4.20	0.44	27.44	63.76	22.00	88.59
PS_1D_1	7.60	6.85	0.15	19.40	49.75	13.21	66.54
PS_1D_2	6.00	6.88	0.12	19.31	47.50	15.96	71.70
PS_1D_3	4.20	7.10	0.11	19.34	43.34	18.84	75.96
PS_1D_4	3.30	7.30	0.10	18.60	42.34	21.66	79.22
PS_1D_5	2.90	7.60	0.09	18.57	38.86	22.29	83.00
PS_2D_1	7.10	4.14	0.36	24.25	55.12	21.89	81.74
PS_2D_2	7.20	4.17	0.32	23.76	54.74	23.43	75.82
PS_2D_3	7.40	4.26	0.29	22.76	50.12	26.10	83.68
PS_2D_4	7.60	4.28	0.26	22.58	48.56	28.06	85.02
PS_2D_5	7.70	4.40	0.25	22.42	42.23	22.10	86.05
PS_3D_1	11.90	4.13	0.42	25.50	61.33	24.51	83.92
PS_3D_2	11.90	4.14	0.39	24.97	58.36	25.31	84.62
PS_3D_3	12.10	4.20	0.36	24.06	56.08	26.00	86.05
PS_3D_4	12.80	4.23	0.35	23.75	55.01	27.68	86.62
PS_3D_5	13.10	4.25	0.33	23.23	53.06	22.05	87.80
PS_4D_1	13.40	4.03	0.47	28.50	66.94	26.43	83.92
PS_4D_2	14.90	4.12	0.44	27.77	64.22	26.85	85.06
PS_4D_3	15.10	4.16	0.43	27.57	61.65	27.16	86.47
PS_4D_4	15.50	4.18	0.41	26.90	59.45	28.05	86.96
PS_4D_5	16.50	4.20	0.39	25.96	56.90	22.00	88.02
PS_5D_1	17.30	4.00	0.51	29.26	71.65	28.26	85.75
PS_5D_2	17.50	4.10	0.48	28.87	69.30	29.11	86.40

PS_5D_3	18.60	4.10	0.45	28.02	68.22	30.17	87.40
PS_5D_4	18.60	4.10	0.43	27.67	65.01	31.10	88.23
PS_5D_5	19.40	4.20	0.42	27.04	63.06	21.99	88.47
CV%	0.86	2.09	3.01	0.50	0.32	0.41	2.13
LSD	0.162	0.162	0.162	0.198	0.294	0.162	2.87

3.3. Microbiological Analysis

The effects of different percentages of salt added and packaging materials for the presence of microbial growth (bacteria, fungi, etc) in the processed ginger paste are shown in Table 6. It was noticed that in control condition the microbial growth were seen using different packaging materials. But, the processed ginger paste was kept and stored up to 4 months in glass container gives best results with no presence of microbial growth although added different salt percentages. Hence, it was processed and stored in plastic container the results of 3% and 12% salt added seen no presence of bacteria up to 1 month at room temperature of 25 to 30 ºC condition.

Table 6: Effect of packaging materials and salt percentages on the presence of bacteria and others microbial growth in processed ginger paste

Treatments	**Microbial growth of processed ginger paste**				
	Duration of storage, months				
	0	**1**	**2**	**3**	**4**
T_1= Control in GC	No	Yes	Yes	Yes	Yes
T_2= Control in PC	No	Yes	Yes and Fungi	Yes	Yes
T_3= 3% salt in GC	No	No	No	No	No
T_4= 3% salt in PC	No	No	Yes	Yes	Yes
T_5= 6% salt in GC	No	No	No	No	No
T_6= 6% salt in PC	No	Yes	Yes	Yes	Yes
T_7= 9% salt in GC	No	No	No	No	No
T_8= 9% salt in PC	No	Yes	Yes	Yes	Yes
T_9= 12% salt in GC	No	No	No	No	No
T_{10}= 12% salt in PC	No	No	Yes	Yes	Yes

Note: No= No bacteria; Yes= presence of bacteria

4. Conclusions

In relation to ginger as we know, Bangladesh is insufficient production country and seasonal in nature with available during only the peak season in the local market. Another important issue is postharvest losses. To reduce spoilage/postharvest losses as acceptable limit our farmers would get more benefits and thus they encouraged to increase the ginger production. Therefore, it necessary to introduce new technology for long time preserve processed ginger paste for consumption in off season. This research investigated the acidity, pH, TSS, dry matter percentage, lightness, chroma and hue angle changes of processed ginger paste to evaluate the packaging effects on the quality and storage stability of the paste using different salt percentages. The results revealed that the processed ginger paste with 12% salt and kept in glass container showed better quality product at room temperature of 25 to 30 ºC condition.

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