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Qualitative changes during storage of different ginger-based spice sauces

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ABSTRACT

Ready-to-eat sauces have become a trend in all kinds of meals. Five ginger-based sauces viz., ginger, ginger-black pepper, ginger-nutmeg, ginger-*kokum* and ginger-nutmeg-kokum were prepared as per standard procedures. Physical, biochemical, microbiological and rheological properties of the sauces were recorded at regular intervals for 135 days. There was no significant variation in physical properties (total soluble solids) during storage but colour value varied significantly. Variation in chemical parameters like pH, content of moisture, proteins, carbohydrates and total sugars was non-significant, but variation in titratable acidity and reducing sugars was significant. Storage period did not affect total plate count, consistency index and flow behavior index of the sauces, which remained constant during the entire storage period. Sensory score of the sauces showed that acceptability was high for ginger sauce, followed by ginger-black pepper and ginger-nutmeg sauce.

Key words: Ginger, sauce, quality, storage, nutmeg, *kokum (Garcinia indica)*

INTRODUCTION

Spices are aromatic materials used for flavoring and seasoning foods. They are valued not only as piquant flavoring agents, but also as appetizers. Some spices possess antioxidant properties, while others are used as preservatives. Many of the spices have medicinal properties and have profound effect on human health. Awareness on nutritional aspects of natural foods has increased the demand for natural products. Spices, being materials of plant origin, are more appealing to consumers than are synthetic food additives.

Ginger (*Zingiber officinale* Roscoe) is widely used around the world in foods as a spice in fresh and dried form. Ginger adds to flavour of a meal, creating a fresh, spicy pungent taste and is now becoming a valued commodity all over the world. Although there is substantial consumption of fresh ginger worldwide, most of the produce is converted into dry ginger (Balakrishnan, 2005). Products made from fresh ginger include ginger preserve, ginger candy, ginger pickles, soft drinks like ginger cocktail, salted ginger, and alcoholic beverages like ginger wine, ginger brandy and ginger beer. Though ginger is widely available in different forms, scope for product diversification in this crop remains very high (Premavalli, 2005).

Thermal processing of fruits and vegetables into jams, jellies, squashes, nectars, sauces and so on is well known all over the world. The term 'sauce' is familiar in case of tomato, onion, chilli, mango, orange, etc. where spices are used minimally. Sauce is a liquid or semi-solid preparation served with foods or used in preparation of foods. A sauce may contain up to 60% solids if it is a Newtonian base. Sauces go through high levels of biochemical changes due to their high moisture content. As biochemical changes occur, solids disperse rapidly into the medium causing rheological changes. The present work was, therefore, taken up to develop a value-added product from ginger, i.e., ginger sauce, by standardizing raw materials used and assess the shelf-life of the product.

MATERIAL AND METHODS

Studies on storage of ginger sauces were conducted during September 2010 at IISR, Peruvannamuzhi Farm, Kozhikode, Kerala. Fresh ginger procured from the local market was washed, peeled and cleaned with water to remove surface impurities. Other raw materials like black pepper, nutmeg rind, *kokum (Garcinia indica)* etc. were obtained from Indian Institute of Spices Research (IISR) Experimental Farm, Peruvannamuzhi.

Ingredients for each sauce were first processed individually by grinding them into a fine paste. The sauces were prepared as per Srivastava and Kumar (1994). Spice

combinations used in the preparation of sauces are detailed in Table 1. The sauces were transferred into washed and sterilized (121°C for 10 min.) glass bottles, capped by a crown corking machine and in-bottle pasteurization was done at 80°C for 20 min. Sauce bottles were then stored at room temperature for 135 days and the quality of stored sauces studied at regular intervals.

Physical properties like total soluble solids (TSS) were measured using Attago (RX 100) digital refractometer (AOAC, 2007) and sauce colour was analyzed using a Colourflex EZ spectrophotometer (Hunter Associates Laboratory, USA). Moisture content of the sauce samples was determined by the toluene distillation method (ASTA, 1997) pH was measured by the method of AOAC (2007); titratable acidity, protein, total carbohydrates, reducing sugars and total sugars were quantified by the method of Sadasivam and Manickam (2008). Microbial analysis was done by the total plate count method (Frazier and Westhoff, 2006).

Rheological measurements were carried in a concentric cylinder [Brookfield rheometer (DV-III+)], using a small sample adapter (13R/RP, 19.05 mm diameter with a depth of 64.77 mm) and spindle SC4-27 (11.76 mm of diameter and 33.02 mm length), (Brookfield Engineering Laboratories, MA, USA). Brookfield TC-500 thermostatic bath (Brookfield Engineering Laboratories, MA, USA) was used for adjusting temperature of the sample to 60°C. Apparent viscosity (ς_{ap}), shear stress (τ) and shear rate ($\dot{\gamma}$) data were obtained using Rheocalc Software (version V2.3, Brookfield Engineering Laboratories, MA, USA). Each experimental run to the upward curve lasted for 4 min. corresponding to 9.6 s × 25 points, with shear rate range from 2.80 to 70 /s, and 4 min to the downward curve with shear rate range from 70 to 2.80 /s.

Table 1. Spice combinations used in ginger sauce preparation

Treatment	Constituents of the sauce	Quantity
T_1	Ginger	6.5 kg fresh ginger
T_2	Ginger + black pepper	6.5 kg fresh ginger, 600 g dry black pepper
T_3	Ginger + nutmeg	2.5 kg fresh ginger 2.5 kg fresh nutmeg rind
T_4	Ginger + *kokum*	2.5 kg fresh ginger 2.5 kg dry *kokum*
T_5	Ginger + nutmeg + *kokum*	1kg fresh ginger, 1kg fresh nutmeg rind, 1 kg dry *kokum*

Table 2. Major biochemical constituents of raw materials used in ginger-based sauce preparation

Parameter (*dwb)	Ginger	Black pepper	Nutmeg rind	*Kokum*
Total starch (g /100 g)	65.1	60.2	60.1	60.1
Total sugars (g /100 g)	3.1	4.1	6.1	4.1
Protein (g /100 g)	2.2	2.5	1.1	1.1
Pectin (g /100 g)	0.2	0.1	5.4	2.1
Fats (g /100 g)	1.1	1.2	6.1	8.1
Essential oils (%)	1.2	1.7	1.1	2.1
Oleoresin (%)	2.3	2.9	2.2	2.1

N = 3; *dwb: dry weight basis

Response of the sauce after application of yield stress was similar to shear thinning flow. Therefore, Herschel Bulkley model was applied to obtain flow behaviour of these sauces, represented as:

$$\tau - \tau_0 = K(\gamma)^n$$

where, τ is shear stress (Pa), τ_0 is yield stress (Pa), γ is shear rate (/s), *K* is consistency coefficient (Pa.s^n), and *n* is flow behaviour index (dimensionless).

Sensory (organoleptic) evaluation was conducted on the sauce samples using quantitative analysis as per Ranganna (1991). Colour, taste, texture, flavor/aroma and overall acceptability were evaluated using the scale of 1 as dislike extremely; 5 as neither like nor dislike; 9 as like extremely.

Analysis of Variance (ANOVA) was performed to evaluate the effect of sauce type and storage quality of the sauce. Freshly prepared sauces were initially analyzed for quality and thereafter, at 15, 30, 60, 75, 90, 105, 120 and 135 days of storage. Three replicates of each treatment were used for quality analysis. Data obtained during storage for various properties of ginger sauces were analyzed using AGRES (version 7.01, Pascal Intl software solutions) statistical software.

RESULTS AND DISCUSSION

Initial biochemical quality parameters of raw materials used for sauce preparation like ginger, black pepper, kokum and nutmeg rind are detailed in Table 2.

TSS and colour values

TSS in the sauce initially for treatments T_1, T_2, T_3, T_4 and T_5 was 28.41, 28.31, 28.51, 28.61 and 28.2° Brix, respectively, and it increased during the storage period to 28.43, 28.33, 28.53, 28.64 and 28.23°Brix, respectively. However, this increase was found to be non-significant (Table 3). Vidhya and Anandhi (2011) reported no change in TSS in wood apple jam and fruit bar stored for 90 days.

Table 3. Variation in total soluble solids content and colour values during storage of ginger-based sauces

Sauce	Storage period (days)									
	0	15	30	45	60	75	90	105	120	135
					Total soluble solids content (°Brix)					
T_1	28.41	28.42	28.42	28.42	28.42	28.43	28.43	28.43	28.43	28.43
T_2	28.31	28.32	28.33	28.33	28.33	28.33	28.33	28.33	28.33	28.33
T_3	28.51	28.52	28.52	28.52	28.53	28.53	28.53	28.53	28.53	28.53
T_4	28.61	28.63	28.63	28.63	28.63	28.63	28.64	28.64	28.64	28.64
T_5	28.21	28.22	28.22	28.22	28.22	28.22	28.22	28.22	28.23	28.23
CD (Pd”0.05)	Sauce (S) = 0.01 Storage period (P)= 0.02 S × P = 0.04									
					Colour value (L*)					
T_1	20.83	20.84	20.85	20.86	20.87	20.89	20.90	20.91	20.91	20.93
T_2	13.41	13.42	13.43	13.45	1.46	13.47	13.48	13.49	13.49	13.51
T_3	33.69	33.70	33.71	33.72	33.73	33.74	33.75	33.76	33.76	33.78
T_4	2.72	2.73	2.74	2.75	2.76	2.77	2.78	2.79	2.79	2.81
T_5	5.70	5.71	5.72	5.73	5.74	5.75	5.76	5.77	5.77	5.79
CD (Pd”0.05)	Sauce (S) = 0.1 Storage period (P) = 0.21S × P = 0.3									
					Colour value (a*)					
T_1	5.61	5.57	5.62	5.62	5.62	5.62	5.63	5.67	5.67	5.67
T_2	5.71	5.78	5.83	5.83	5.87	5.87	5.89	5.91	5.93	5.95
T_3	17.54	17.61	17.68	17.69	17.71	17.71	17.73	17.75	17.77	17.79
T_4	5.40	5.38	5.36	5.35	5.34	5.34	5.34	5.31	5.31	5.30
T_5	25.79	25.78	25.76	25.76	25.75	25.74	25.73	25.73	25.72	25.70
CD (Pd”0.05)	Sauce (S) = 0.04 Storage period (P) = 0.06S × P = 0.1									
					Colour value (b*)					
T_1	22.40	22.87	22.96	22.99	23.24	23.26	23.28	23.28	23.30	23.32
T_2	16.61	16.71	16.72	16.73	16.77	16.79	16.81	16.81	16.83	16.85
T_3	26.82	27.12	27.18	27.26	27.72	27.42	27.44	27.89	27.92	27.98
T_4	4.01	4.03	4.04	4.07	4.07	40.07	4.07	4.07	4.07	4.07
T_5	8.81	8.66	8.60	8.56	8.56	8.56	8.56	8.56	8.56	8.56
CD (Pd”0.05)	Sauce (S) = 0.04 Storage period (P) = 0.06S × P = 0.1									

Colour values were measured in terms of lightness (‘L’), redness (‘a’) and yellowness (‘b’) as per Hunter scale and showed significant increase during storage. Initial values for L^* for treatments T_1, T_2, T_3, T_4 and T_5 corresponded to 20.83, 13.41, 33.69, 2.72 and 5.72; initial values for a^* corresponded to 5.61, 5.71, 17.54, 5.40 and 25.79 and initial values for b^* corresponded to 22.40, 16.61, 26.82, 4.01 and 8.81 (Table 3). At 135 days of storage, values for L^* for treatments T_1, T_2, T_3, T_4 and T_5 increased to 20.93, 13.52, 33.78, 2.81 and 5.79, respectively; values for a^* corresponded to 5.67, 5.95, 17.79, 5.30 and 25.70, and values for b^* corresponded to 23.32, 16.85, 27.98, 4.07 and 8.56. Analysis of variance indicated increase in the values of L^*, a* and b* to be significant (Pd” 5%).

From the colour values obtained, it may be interpreted that ginger sauce was darker, less green and yellower. Ginger-black pepper sauce was close to black, less green and yellower; ginger-kokum sauce was lighter, less red and less yellow; and ginger-nutmeg sauce was lighter, less red and less yellow. But, ginger-nutmeg-*kokum* sauce was darker, redder and less yellow. This observation for colour remained the same throughout storage period of 135 days (Table 3). Consistency in colour during storage was also reported by Ahmed *et al* (2004) for coriander leaf puree and Ahmed (2004) for ginger paste.

pH and titratable acidity

pH values for the five sauces showed non-significant increase during storage. Initial pH determined for treatments T_1, T_2, T_3, T_4 and T_5 was 4, 3.5, 3.75, 3.2 and 4.2, respectively. Vidhya and Anandhi (2011) reported a constant value of pH during storage of wood apple jam and fruit bar for a period of 90 days.

Increase in titratable acidity was found in treatments T_2 (from 0.25 to 0.26%), T_3 (0.49 to 0.52%) and T_5 (0.49 to 0.54%). Titratable acidity for treatment T_1 increased from 0.13 to 0.14% after 60 days, and, reduced to 0.12% towards the end of the storage period, while, for Treatment T_5,

titratable acidity increased from 0.49 to 0.57% after 30 days, and reduced to 0.54% towards the end of the storage period at 135 days. The increase in acidity may be due to conversion of some amount of sugar to acids (Babskey and Toribo, 1986). Increase in titratable acidity was reported in stone apple RTS (Rayaguru, 2008), hot pepper paste (Bozkurt and Erkmen, 2004) and pistachio nut paste (Gamli and Hayoglu, 2007).

Moisture content

Increase in moisture content of the sauces was observed during storage. Initially, moisture content of sauces in treatments T_1, T_2, T_3, T_4 and T_5 corresponded to 65.14, 63.12, 64.11, 62.12 and 64.11%, respectively. Towards the end of storage period, it corresponded to 65.17, 63.14, 64.12, 62.15 and 64.19%, respectively (Table 4). However, this change was found to be non-significant.

Carbohydrate and protein content

The amount of carbohydrates in the sauces in treatments T_1, T_2, T_3, T_4 and T_5 showed non-significant increase from initial values of 7.63, 7.63, 7.63, 7.64 and 7.64 g/100 ml, to final values of 7.65, 7.64, 7.65 and 7.65 g/100 ml, respectively (Table 5). Protein content of the sauces in treatments T_1, T_2, T_3, T_4 and T_5 was 9.01, 9.14, 9.24, 9.32 and 9.42 g/100 ml, and increased to 9.02, 9.15, 9.25, 9.33 and 9.47 g/100 ml, respectively. No significant variation in the amount of protein was observed during storage.

Reducing and total sugars content

The amount of reducing sugars in all the sauces followed an increasing trend during storage (Table 6). Initial

Table 4. Variation in titratable acidity and moisture content during storage of ginger-based sauces

Sauce	Titratable acidity (%)									
	Storage period (days)									
	0	15	30	45	60	75	90	105	120	135
T_1	0.13	0.13	0.13	0.13	0.14	0.13	0.12	0.13	0.13	0.12
T_2	0.25	0.25	0.24	0.25	0.24	0.26	0.26	0.26	0.26	0.26
T_3	0.49	0.54	0.55	0.55	0.53	0.55	0.53	0.52	0.52	0.52
T_4	0.23	0.21	0.24	0.24	0.21	0.23	0.25	0.24	0.22	0.22
T_5	0.49	0.53	0.57	0.50	0.53	0.54	0.54	0.54	0.54	0.54
CD (Pd”0.05) Sauce (S) = 0.01 Storage period (P) = 0.01S × P = 0.03										
	Moisture content (%)									
T_1	65.14	65.16	66.16	65.16	65.17	65.17	65.17	65.17	65.17	65.17
T_2	63.12	63.13	63.13	63.13	63.13	63.13	63.14	63.14	63.14	63.14
T_3	64.11	64.11	64.11	64.12	64.12	64.12	64.12	64.12	64.12	64.12
T_4	62.12	62.14	62.14	62.14	62.14	62.14	62.15	62.15	62.15	62.15
T_5	64.11	64.18	64.18	64.18	64.19	64.19	64.19	64.19	64.19	64.19
CD (Pd”0.05) Sauce (S) = 0.01 Storage period (P) = 0.01S × P = 0.03										

Table 5. Variation in carbohydrate and protein content during storage of ginger-based sauces

Sauce	Carbohydrate content (g /100 ml)*									
	Storage period (days)									
	0	15	30	45	60	75	90	105	120	135
T_1	7.63	7.62	7.63	7.63	7.64	7.64	7.65	7.65	7.65	7.65
T_2	7.62	7.62	7.63	7.63	7.63	7.63	7.63	7.64	7.64	7.64
T_3	7.63	7.63	7.63	7.64	7.64	7.64	7.64	7.64	7.64	7.64
T_4	7.64	7.64	7.64	7.65	7.65	7.65	7.65	7.65	7.65	7.65
T_5	7.64	7.64	7.64	7.65	7.65	7.65	7.65	7.65	7.65	7.65
CD (Pd”0.05) Sauce (S) = 0.02 Storage period (P) = 0.02S × P = 0.04										
	Protein content (g /100 ml)*									
T_1	9.01	9.02	9.02	9.02	9.02	9.02	9.02	9.02	9.02	9.02
T_2	9.14	9.13	9.13	9.14	9.14	9.14	9.15	9.15	9.15	9.15
T_3	9.24	9.24	9.24	9.24	9.25	9.25	9.25	9.25	9.25	9.25
T_4	9.32	9.32	9.33	9.33	9.33	9.33	9.33	9.33	9.33	9.33
T_5	9.42	9.41	9.42	9.43	9.45	9.47	9.47	9.47	9.47	9.47
CD (Pd”0.05) Sauce (S) = 0.01 Storage period (P) = 0.02S × P = 0.2										

*On fresh weight basis of sauce

Table 6. Variation in reducing sugar content (g/100 ml) during storage of ginger-based sauces

Sauce	Storage period (days)									
	0	15	30	45	60	75	90	105	120	135
T_1	5.84	6.06	6.48	6.60	7.70	8.41	9.25	9.32	9.35	9.38
T_2	6.97	7.22	7.72	8.33	9.18	9.70	10.69	10.92	10.95	10.98
T_3	6.91	7.27	7.92	8.29	9.21	10.19	10.80	10.96	10.99	11.03
T_4	6.87	6.99	7.40	7.80	8.42	9.23	10.13	10.65	10.68	10.71
T_5	6.15	6.71	7.30	7.92	8.96	9.49	10.22	10.25	10.38	11.03

CD (Pd"0.05) Sauce (S) = 0.37 Storage period (P) = 0.01S × P = 0.024
*On fresh weight basis of sauce

Table 7. Variation in consistency and flow-behavior during storage of ginger-based sauces

Sauce	Consistency Index											
	Storage period (days)											
	0	15	30	45	60	75	90	105	120	135	R^2	SE
T_1	29.52	29.52	29.52	29.52	29.52	29.52	29.52	29.52	29.52	29.52	0.91	0.04
T_2	35.14	35.14	35.14	35.14	35.14	35.14	35.14	35.14	35.14	35.14	0.92	0.03
T_3	39.82	39.82	39.82	39.82	39.82	39.82	39.82	39.82	39.82	39.82	0.94	0.05
T_4	31.31	31.31	31.31	31.31	31.31	31.31	31.31	31.31	31.31	31.31	0.95	0.07
T_5	34.61	34.61	34.61	34.61	34.61	34.61	34.61	34.61	34.61	34.61	0.96	0.05
	Flow-behavior index											
T_1	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.91	0.04
T_2	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.92	0.03
T_3	1.61	1.61	1.61	1.61	1.61	1.61	1.61	1.61	1.61	1.61	0.94	0.05
T_4	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.95	0.07
T_5	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.96	0.05

N = 3; R^2: Regression co-efficient, SE: Standard Error

amount of reducing sugars in treatments T_1, T_2, T_3, T_4 and T_5 corresponded to 5.84, 6.97, 6.91, 6.87 and 6.15 g/100 ml, and after 135 days of storage, it increased significantly to 9.38, 10.98, 11.03, 10.71 and 11.03 g/100 ml, respectively. In spite of the increasing trend in reducing sugars, the amount of total sugars during storage in treatments T_1, T_2, T_3, T_4 and T_5 remained constant at 18.33, 22.41, 20.83, 19.81 and 20.15 g/100 ml, respectively (Table 6). Thus, storage period did not have significant influence on the amount of total sugars. The change in sugar content can be explained to be due to sucrose reduction (reducing sugar reduction) into stable glucose (Yosuf *et al*, 1989).

Consistency and flow-behaviour index

Rheological properties evaluated for the sauces using Brookfield rheometer indicated that the flow of ginger sauces was non-Newtonian. Therefore, Herschell Bulkley model was applied and consistency index (K) and flow-behaviour index (η) were derived. Initially, sauces in treatments T_1, T_2, T_3, T_4 and T_5 had consistency index of 20.52, 35.14, 39.82, 31.31 and 34.61, and flow-behaviour index of 0.57, 0.46, 1.61, 0.61 and 0.66, respectively (Table 7). Values for both the properties remained constant even at storage for 135 days. Ahmed *et al* (2007) reported that under steady shear deformation tests, shear stress – shear strain data could adequately be represented in Herschell Bulkley model up to a temperature of 30°C.

Total plate count

In the treatments T_1, T_2, T_3, T_4 and T_5, there was no indication of bacterial or fungal growth, as the colonies were too few to count by the total plate count method. Therefore, the processed sauces were free from contamination both due to external and internal factors. This was due to retention of optimum levels of TSS and acidity initially (at the time of preparation) which prevented deteriorative reactions that influence the product (Relekar *et al*, 2011). No bacterial or fungal growth during storage was reported by Gokoglu *et al* (2009) for pomegranate sauce for eight months and by Ahmed (2004) for storage of ginger paste.

Overall acceptability score

Sensory analysis showed that ginger sauce had the best flavour and taste, with overall acceptability score of 8.0; the next was ginger-pepper sauce with acceptability score of 7.1, followed by ginger-nutmeg sauce with a score of 6.4 (Table 8). Ginger-*kokum* and ginger-nutmeg-*kokum* sauces had a near-similar acceptability score of 5.3.

Table 8. Sensory score (Hedonic scale*) for overall acceptability of ginger sauces

Sauce	Storage period (days)					
	0	30	60	90	120	135
T_1	8.5	8.5	8.4	8.3	8.1	8.0
T_2	7.5	7.5	7.4	7.4	7.3	7.3
T_3	6.6	6.5	6.5	6.4	6.4	6.2
T_4	6.0	5.5	5.5	5.4	5.3	5.3
T_5	5.5	5.5	5.4	5.4	5.3	5.1

CD (Pd"5%) Sauce (S) = 0.01 Storage period (P) = 0.01S × P = 0.02
*Hedonic scale score: 1 as dislike extremely; 5 as neither like nor dislike; 9 as like extremely

To summarize the study on storage of five ginger-based sauces, ginger, ginger-black pepper, ginger-nutmeg, ginger-*kokum* and ginger-nutmeg-*kokum* for a period of 135 days, it was found that there was no significant variation in physical properties like total soluble solids content during storage, but colour value varied significantly. Other parameters like pH, moisture content, protein content, total carbohydrates and total sugars did not show significant differences during storage. But, variations in titratable acidity and content of reducing sugars were significant. Storage period did not affect total plate count, consistency index and flow-behaviour index of the sauces, which remained constant during the entire storage period. Sensory score based on overall acceptability indicated that acceptability score was highest for ginger sauce, followed by ginger-black pepper and ginger-nutmeg sauces.

REFERENCES

Ahmed, J. 2004. Rheological behavior and colour changes of ginger paste during storage. *Int'l. J. Food Sci. Tech.*, **39**:325-330

Ahmed, J., Shivhare, U.S. and Singh, P. 2004. Colour kinetics and rheology of coriander leaf puree and storage characteristics of the paste. *Food Chem.*, **84**:605-611

Ahmed, J., Ramaswamy, H.S., and Sashidhar, K.C. 2007. Rheological characteristics of tamarind (*Tamarindus indica* L.). *LWT - Food Sci. Tech.*, **40**:225-231

AOAC, 2007. *Official Methods of Analysis*. Association of Official Analytical Chemists (2nd edn.), Washington DC

ASTA, 1997. *Official Analytical Methods of the American Spice Trade Association* (4th edn.), New Jersey

Babskey, N.E. and Toribo, J.L. 1986. Influence of storage on the composition of clarified apple juice concentrates. *J. Food Sci*., **5**:564-565

Balakrishnan, K.V. 2005. Postharvest and industrial processing of ginger. In: *Ginger - The Genus Zingiber,* Ravindran P.N. and Babu K.N. (Eds.). CRC Press, Boca Raton, FL, pp. 391- 434.

Bozkurt, H. and Osman Erkmen. 2004. Effects of production techniques on the quality of hot pepper paste. *J. Food Engg.*, **64**:173-178

Frazier, W.C. and Westhoff, D.C. 2006. *Microbiology of Foods.* McGraw-Hill Publication Company Limited, New Delhi, pp. 212

Gamli, F.O. and Ibrahim, H. 2007. The effect of different packaging and storage conditions on the quality of pistachio nut paste. *J. Food Engg.*, **78**:443-448

Gokoglu, N., Osman, K.T. and Pinar, Y. 2009. Effects of pomegranate sauce on quality of marinated anchovy during refrigerated storage. *LWT - Food Sci. Tech.*, **42**:113-118

Premavalli, K.S. 2005. Ginger as a spice and flavorant. In: *Ginger - The Genus Zingiber.* Ravindran, P.N. and Babu, K.N. (Eds.). CRC Press, Boca Raton, FL, pp. 509–525.

Ranganna, S. 1991. *HandBook of Analysis and Quality Control for Fruit and Vegetable Products* (2nd edn.). Tata McGraw Hill Publishing Company Limited, New Delhi

Rayaguru, K., Md.K. Khan and N. R. Sahoo. 2008. Effect of storage on quality of stone apple ready-to-serve beverage. *J. Agril. Engg.*, **45**:62-68

Relekar, P.P., Naik, A.G. and Padhiar, B.V. 2011. Qualitative changes in value-added products of sapota cv. Kalipatti during storage. *Ind. J. Hort.*, **68**:413-418

Sadasivam, S. and Manickam, A. 2008. *Biochemical Methods for Agricultural Sciences (*6th Edn.), New Age International (P) Limited, New Delhi

Srivatsava, R.P. and Kumar, S. 1994. *Fruit and Vegetable Preservation- Principles and Practices*. International Book Distributing Co., Lucknow, pp. 200-207

Vidhya, R. and Anandhi, N. 2011. Formulation and evaluation of preserved products utilizing under-exploited fruit, wood Apple *(Limonia acidissima). American-Eurasian J. Agri. & Environ. Sci.*, **10**:112-118

Yousuf, M.Y., Khan, L. and Kamal, X. 1989. Biochemical changes in sugarcane juice. *J. Food Sci. Tech.*, **26**:214-213

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