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RESEARCH PAPER

Effect of Blanching on Quality Characteristics of Osmotically Dried and Appetized Ginger Flakes

Manisha Kaushal*, Aarti Dhiman, Devina Vaidya, Anil Gupta and Anil Verma

Department of Food Science & Technology, Dr Y S Parmar University of Horticulture & Forestry Nauni, Solan, HP, India

*Corresponding author: manishapht@gmail.com

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Abstract

Studies were conducted to develop a novel product- osmotically dried and appetizing flakes from fresh ginger rhizomes keeping in view its nutritional significance. Ginger contains ascorbic acid (8.48 mg/100 g), antioxidant activity (57.45%), crude protein (2.73%) and total phenols (10.18 mg/100 g) that accounts for its characteristic aroma and therapeutic properties. Mechanically peeled rhizomes were sliced into suitable size of 3.5×0.4×0.4 cm^3 followed by blanching in 1.0% lemon juice or citric acid for 15 minutes for the preparation of osmotically dried and appetized ginger flakes. The cost of production of osmotically dried ginger flakes was calculated as ₹ 22.64 to 22.97/200g for glass jars and ₹ 15.65 to ₹ 15.72/ 200g for aluminium laminated pouches for citric acid and lime juice blanching, respectively. The commercial adoption of this technology seems to be a profitable venture for efficient utilization of fresh ginger rhizome as well as enhancing the income of growers.

Keywords: Ginger, flakes, blanching, lime juice, osmotic dehydration, appetizing mixture, dehydration ratio

Ginger is widely used around the world in food as a spice both in fresh and dried form which adds flavour to the meal by creating spicy pungent taste (Jayashree *et al*., 2012). Ginger contains polyphenolic compounds such as gingerol and its derivatives (Chen *et al*., 1986 and Rahman *et al*., 2013) such as zingiberone, bisabolene, camphene, geranial, linalool, borneol and oleoresin (combination of volatile oils and resin) that accounts for its characteristic aroma and therapeutic properties. Ginger rhizome is typically consumed as fresh or processed into paste, concentrate, dried *ginger* (sonth) or for flavoring tea (Sambasivam and Girija, 2006). Processing ginger into dried product is an important method of reducing perishability and also to increase storage stability (Pezzutti and Crapiste, 1997). The dry ginger is valued for its aroma, flavour and pungency (Balakrishnan, 2005). Peeling or scraping is advised for reducing drying time, it also tends to remove some of the oils constituents as they are more concentrated in the peel. The peeled rhizomes may be bleached to improve appearance. Traditionally, rhizomes are treated for 10 minutes in boiling water, which also inactivates enzymatic processes followed by sun-drying (Sutarno *et al*., 1999). Further, blanching also improves the osmosis process and helps in more water loss in case of osmotically dried Mexican ginger (Garcia-Toledo *et al*., 2015).

Generally, ginger is sun dried in a single layer in open yard which takes about 8 to 10 days for complete drying. The sun dried ginger is brown in colour with irregular wrinkled surface. The yield of dry ginger is about 19-25 per cent of fresh ginger depending on the variety and climatic zone (IISR, 2015). Conventional drying method reduces the moisture content and increases the shelf-life of the product; but it often

results in loss of nutrients and has an adverse effect on the flavor and appearance (colour) of the product. Therefore, osmotic dehydration may provide an option for removing water without any adverse effects on food (Santagapita *et al.,* 2013 and Silva *et al.,* 2014).

Osmotic dehydration also provides better control of flavor, colour with minimum tissue damage and improved nutrient retention (Nowacka *et al.,* 2014). According to Siddiqui *et al.* (2012) ginger preserve with 70 per cent sugar concentration and candy from 75 per cent sugar concentration were found the best with respect to quality parameters. Bhuyan and Prasad (1990) studied the effect of varied drying temperature (70-90°C) on the quality of dried ginger and optimized drying at 60 to70°C air temperature, while Richardson (1966) recommended ginger drying at 57.3°C and 83°C for spice market. Keeping in view the possibilities of utilizing fresh tender ginger for development of osmotically dried products, the present study was carried out to develop a novel product like osmotically dried and appetized flakes which would serve as a mouth freshener.

MATERIALS AND METHODS

Procurements of raw material

Raw material *viz.*, tender ginger rhizome (cv. Himgiri) and different ingredients like lemon, sugar, salt, black salt, thyme seed, mint etc., used for conducting this study were procured from the local market of Solan, HP, India.

Preparation of ginger flakes

For the preparation of ginger flakes, the rhizomes were peeled by the standardized method given by Kaushal *et al.* (2014) and sliced into suitable size of 3.5 × 0.4 × 0.4 cm^3, followed by blanching (100°C) in either 1.0% lemon juice or 1.0% citric acid for 15 minutes for effective osmosis and drying (Table 1).

On the basis of sensory scoring the pre-treatment attaining the highest scores was selected for further studies. The blanched ginger flakes (Table 1) were osmotically dehydrated in different sugar concentrations (dry sugar, 70% and 50%) and different time durations (3, 4 and 5 hours) to standardize the optimum conditions for osmosis.

Experimental plan

Table 1: Treatment detail of osmotic dehydration of ginger flakes

Treatments	Sugar concentrations (%)		
	100 (dry sugar)	70	50
	Immersion time (h)		
Citric acid blanched flakes	3	3	3
	4	4	4
	5	5	5
	100 (dry sugar)	70	50
Lime juice blanched flakes	3	3	3
	4	4	4
	5	5	5

Product preparation

The flakes were dried in a mechanical dehydrator (Widsons Scientific Works, Delhi) at 55±2°C to 12-14 per cent moisture content. According to Ravindran and Nirmal, (2005), 57.2°C was reported to be the highest temperature in mechanical dryers, at which ginger for the spice market could be dehydrated. Further, the best treatment combination from the experiment (Table 1) was rolled into the appetizing mixture containing common and black salt (28.5% each), thyme seed powder (14.5%) and mint powder (28.5%). Different concentrations of 1.0, 1.5, 2.0 and 2.5 per cent appetizing mixture were rolled over the osmotically dried ginger flakes to standardize the most suitable and palatable concentration of appetized mixture.

Analysis

Physico-chemical analysis of fresh and peeled ginger rhizomes and flakes was conducted by using standard analytical procedures (AOAC, 2005; Ranganna, 1997). Total soluble solid (TSS) content

of fresh and processed products was determined by using hand refractometer and sugars were estimated by Lane and Eynon method as detailed by Ranganna (1997). The titratable acidity, reducing sugars and total sugars, ascorbic acid and crude protein were estimated by following the method given in AOAC (2005). The moisture content was estimated by drying the weighed sample up to a constant weight in hot air oven at 70±2ºC and expressed in terms of percentage. Total phenols content was estimated on the basis of their reaction with an oxidizing agent phosphomolybdate in Folin-Ciocalteau reagent under alkaline conditions extracted in 80 per cent ethanol (Bray and Thorpe, 1954). Crude fibre in per cent (w/w) was calculated by the method of AOAC (2005) while the antioxidant activity was measured by method described by Brand *et al.* (1995).

Drying rate and ratio: The rate of dehydration per unit time was calculated by placing a weighed quantity of treated ginger (200 g) on a stainless steel tray (30×20 cm^2) followed by drying in a mechanical dehydrator (55±2ºC) to a moisture content of 12.0 per cent (w/w). The loss in weight during drying was recorded at a periodic interval which was then, calculated by plotting the per cent moisture on dry weight basis against time in hours (Fellows, 1988), whereas the ratio between fresh weight of material before drying to that of dried weight represented the dehydration ratio of given samples (Ranganna, 1997).

***Sensory analysis*:** Sensory evaluation of appetizing ginger flakes was carried out according to Amerine *et al*. (1965). The products were evaluated by a semi-trained panel of judges for various quality attributes viz., colour, texture, flavour, taste and over all acceptability on a 9 point Hedonic Scale.

***Statistical analysis*:** The data on chemical characteristics of fresh and processed ginger were analyzed statistically by following Completely Randomized Design (CRD) detailed by Cochran and Cox (1987), while data pertaining to sensory evaluation were analyzed according to Randomized Block Design (RBD) as described by Mahony (1985). Triplicate determinations were made for each attributes.

RESULTS AND DISCUSSION

Physico-chemical characteristics of fresh and peeled ginger: Physico-chemical characteristics of fresh and peeled ginger rhizome presented in Table 2 revealed that the presence of high moisture content (82.39% and 84.76%) and low titratable acidity (0.15% and 0.16%) as citric acid, respectively in fresh and peeled ginger, emphasized the need of proper postharvest management. The amount of ascorbic acid (8.48 and 6.36 mg/100 g), total phenols (10.18 and 9.81mg/100 g), antioxidant activity (57.45 and 46.60 %), protein (2.73 and 2.56 %) in fresh and peeled ginger respectively further highlighted the nutritional significance of ginger.

Table 2: Physico-chemical characteristics of fresh and peeled ginger rhizomes

Characteristics	(Mean ± SD)	
	Fresh ginger	**Peeled ginger**
Weight (g)	116.77 ± 1.46	—
Volume (cc)	108.15 ± 1.52	—
Density (g/cc)	1.07 ± 0.01	—
Firmness (kg/cm^2)	11.50 **± 0.10**	10.25**± 0.15**
Moisture (%)	82.39 **± 0.05**	84.76 **± 0.05**
TSS (^{0}B)	2.7 ± 0.10	3.0 ± 0.10
Titratable acidity (%)	0.15 ± 0.02	0.16 ± 0.03
pH	6.53 ± 0.02	6.44 ± 0.04
Reducing sugars (%)	0.75 ± 0.21	0.78 ± 0.15
Total sugars (%)	1.26 ± 0.02	1.86 ± 0.05
Ascorbic acid (mg/100 g)	8.48 ± 0.53	6.36 ± 1.06
Total phenols (mg/100g)	10.18 ± 0.03	9.81 ± 0.05
Antioxidant activity (%)	57.45 ± 0.60	46.60 ± 0.67
Crude Protein (%)	2.73 ± 0.06	2.56 ± 0.05
Crude fibre (%)	1.41 ± 0.02	1.40 ± 0.03
Total ash (%)	1.66 ± 0.02	1.34 ± 0.03
Oleoresin (%)	5.01 ± 0.05	—
Oil (%)	1.63 ± 0.01	—

*All values are the mean of 10 observations; SD = Standard deviation

Table 3: Effect of different blanching methods on the *sensory characteristics of ginger flakes

Treatment (Methods of blanching)	Colour	Texture	Flavour	Taste	Overall Acceptability
B_1 (Water)	7.67	7.00	7.11	7.13	7.03
B_2 (1.0% Citric acid)	8.24	8.07	8.16	8.18	8.10
B_3 (1.0% Lime juice)	8.22	8.11	8.18	8.19	8.12
$CD_{P \geq 0.05}$	0.37	0.31	0.01	0.19	0.06

*On 9 point hedonic scale

Crude fibre and total ash was found to be 1.41 %, 1.40% and 1.66%, 1.34%, respectively for fresh and peeled ginger, while oleoresin and oil contents were 5.01 and 1.63 per cent, respectively in ginger (dwb). These values are in conformity with the result reported by Onyenekwe and Hashimoto (1999), Abeyesekera *et al*. (2005), Sultan *et al*. (2005), Eze and Agbo (2011), Jayashree and Visvanathan (2011), Shahid and Hussain (2012) and Rahman *et al*. (2013).

Standardization of blanching method for the preparation of ginger flakes

The ginger rhizome after peeling were sliced into standardized size of 3.5 × 0.4 × 0.4 cm^3 and were subjected to different blanching types (water blanching, 1% citric acid blanching and 1% lime juice blanching) for 15 minutes before drying. The results pertaining to standardization of blanching method on basis of sensory evaluation are presented in Table 3 & Plate I. The results showed that the treatment B_3 (1% lime juice blanching) was superior among all blanching methods with a sensory score for colour (8.22), texture (8.11), flavour (8.18), taste (8.19) and overall acceptability (8.12). However, a higher score for colour (8.24) was received by treatment B_2 (1% citric acid blanching). Both citric acid blanching and lime juice blanching were statistically at par with each other.

The sensory scores were found statistically significant for treatments B_2 and B_3 and were found to better on the basis of sensory scores for the preparation of ginger flakes than the contrast.

Effect of blanching on chemical characteristics of dried ginger flakes

The data pertaining to the effect of pre-treatments on drying behaviour of ginger flakes after blanching (1.0% citric acid and 1.0% lime juice blanching) is presented in Table 4. Before drying, pre-treatments are one of the most important unit operations to improve the final quality of the product (Nilinkara *et al*., 2009). The mean duration of drying of ginger flakes after blanching ranged between 6.20 to 6.25 hours, with the yield of 15.75 to 15.81 per cent and dehydration ratio of 6.32:1 to 6.34:1, irrespective of blanching method. Muhammad *et al*. (2015) observed that dehydration ratio of mechanically dehydrated carrot slices varied between from 7.66 to 7.83. The ginger flakes blanched with 1% citric acid were observed to contain moisture content (12.17%), crude fibre (1.49%), total soluble solids (10.00^0B), titratable acidity (0.38%) with ascorbic acid (5.11mg/100 g), total phenols (10.54 mg/100 g), and antioxidant activity (72.43%), whereas, the ginger flakes blanched with 1% lime juice contained moisture content (12.22 %), crude fibre (1.49%), ascorbic acid (5.06 mg/100 g), total phenols (10.76 mg/100 g) with antioxidant activity of 73.59%.

Osmotic dehydration of ginger flakes

After the standardization of blanching method, the ginger flakes were osmotically dehydrated in three different sugar concentrations (dry sugar, 70% and 50% syrup) for 3, 4 and 5 hours followed by drying in a mechanical dehydrator (55±2°C). The data presented in Table 5, regarding optimization of concentration

Plate 1: Effect of blanching on ginger flakes

Table 4: Effect of blanching methods on chemical characteristics of dried ginger flakes

Characteristics \ Blanching Methods	1% Citric acid	1% Lime juice
Drying time (hours)	6.20 ± 0.10	6.25± 0.01
Yield (%)	15.81± 0.02	15.75± 1.12
Dehydration ratio	6.34: 1 ± 0.01	6.32: 1 ± 0.01
Moisture (%)	12.17 ± 0.02	12.22 ± 0.05
TSS (^{0}B)	10.00 ± 0.20	10.00 ± 0.20
Titratable acidity (% Citric acid)	0.38 ± 0.01	0.31 ± 0.02
pH	4.27 ± 0.01	4.33 ± 0.02
Reducing sugars (%)	1.21 ± 0.02	1.25 ± 0.02
Total sugars (%)	6.56 ± 0.01	6.98 ± 0.02
Ascorbic acid (mg/100 g)	5.11 ± 0.03	5.06 ± 0.01
Total Phenols (mg/ 100g)	10.54 ± 0.04	10.76 ± 0.05
Antioxidant activity (%)	72.43 ± 0.05	73.59 ± 0.04
Total ash (%)	1.36 ± 0.01	1.33 ± 0.01
Crude fibre (%)	1.49 ± 0.01	1.46 ± 0.01

of hypertonic sugar solution and time of dipping showed significantly higher scores for colour (8.33), texture (8.25), flavour (8.42), taste (8.58) with overall acceptability of 8.44 in case of treatment O_9 (1% lime juice blanching, 70% sugar syrup, 4 hrs dip at 40^{o}C), and similarly treatment O_{10} (1% citric acid blanching, 70% sugar syrup, 4 hrs dip at 40^{o}C) also were at par for values for colour (8.36), texture (8.22), flavour (8.40), taste (8.57) with overall acceptability of 8.42.

The organoleptic scores for all the treatments were in the acceptable limits but on the basis of the highest scores, treatments O_9 and O_{10} were selected for the preparation of osmotically dried ginger flakes.

Effect of osmotic dehydration on drying behaviour of ginger flakes

The data pertaining to the effect of osmotic dehydration on drying behaviour of ginger flakes after blanching (1% citric acid and 1% lime juice blanching) are presented in Table 6. The mean duration of drying of blanched ginger flakes after osmosis ranged between 4.20 to 4.25 h with the yield of osmotic dehydrated flakes between 54.14 to 55.83 per cent. The dehydration curve for osmotically dried ginger flakes presented in Fig. 1 shows that in comparison to total period of drying the rate of dehydration was very fast during initial period of drying. Similarly, Chavan and Amrowicz

Table 5: Sensory evaluation* of osmotically dried ginger flakes

Treatment	Colour	Texture	Flavour	Taste	Overall acceptability
O_1 (#LB, 100% sugar, 3 h)	7.28	7.19	7.19	7.19	7.19
O_2 (#CA, 100% sugar, 3 h)	7.26	7.15	7.17	7.18	7.18
O_3 (LB, 100% sugar, 4 h)	7.27	7.21	7.18	7.19	7.16
O_4 (CA, 100% sugar, 4 h)	7.28	7.20	7.16	7.22	7.14
O_5 (LB, 100% sugar, 5 h)	7.32	7.23	7.20	7.22	7.22
O_6 (CA, 100% sugar, 5 h)	7.29	7.22	7.18	7.28	7.21
O_7 (LB, 70% sugar, 3 h)	7.30	7.30	7.26	7.38	7.27
O_8 (CA, 70% sugar, 3h)	7.32	7.29	7.23	7.35	7.26
O_9 (LB, 70% sugar, 4 h)	8.33	8.25	8.42	8.58	8.44
O_{10} (CA, 70% sugar, 4h)	8.36	8.22	8.40	8.57	8.42
O_{11} (LB,70% sugar, 5h)	7.40	7.20	7.53	7.57	7.36
O_{12} (CA, 70% sugar, 5h)	7.41	7.18	7.51	7.56	7.35
O_{13} (LB, 50% sugar, 3h)	7.37	7.14	7.46	7.52	7.40
O_{14} (CA, 50% sugar, 3h)	7.38	7.15	7.44	7.50	7.38
O_{15} (LB, 50% sugar, 4h)	7.36	7.16	7.41	7.48	7.26
O_{16} (CA, 50% sugar, 4h)	7.37	7.14	7.39	7.47	7.24
O_{17} (LB, 50% sugar, 5h)	7.39	7.20	7.40	7.43	7.29
O_{18} (CA, 50% sugar, 5h)	7.40	7.14	7.33	7.41	7.28
$CD_{P\geq0.05}$	0.05	0.04	0.14	0.03	0.03

*On 9 point hedonic scale; #LB = Lime juice blanching, #CA = Citric acid blanching

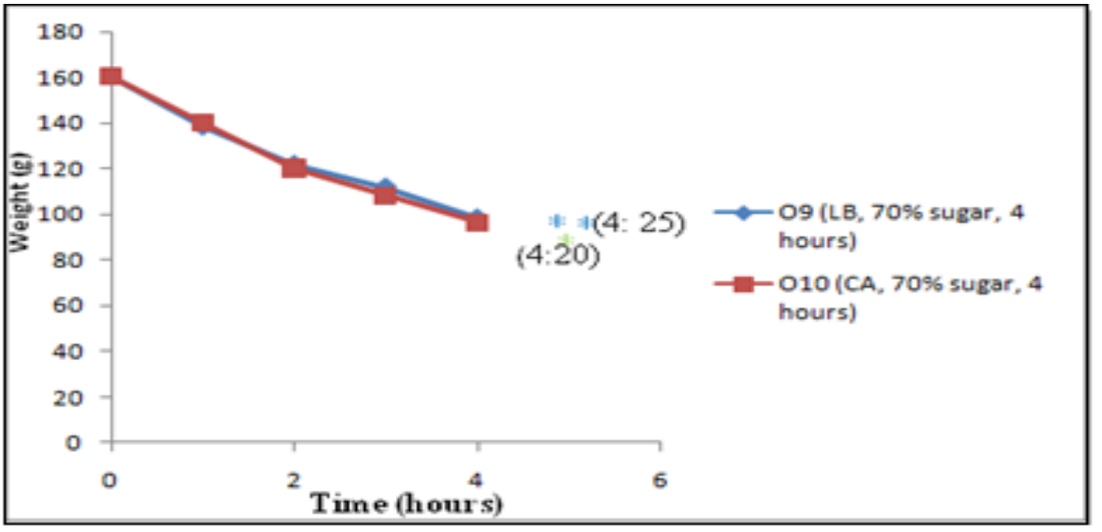

Fig. 1: Dehydration curve for osmotically dried ginger flakes

Table 6: Effect of osmotic dehydration on drying behaviour of ginger flakes

Pre-treatment	Drying time (hrs)	Yield (%)	Dehydration ratio
O_9 (#LB, 70% sugar, 4 hours)	4.25	54.14	1.84 : 1
O_{10} (#CA, 70% sugar, 4 hours)	4.20	55.83	1.79 : 1

LB = Lime juice blanching, #CA = Citric acid blanching

Table 7: Sensory evaluation* of osmotically appetized dried ginger flakes

Treatment	Colour	Texture	Flavour	Taste	Overall acceptability
A_0 (#LB,70% sugar, 4 h + 1.0% appetizing mixture)	7.45	7.65	7.69	7.72	7.47
A^1 (#CA, 70% sugar, 4 h + 1.0% appetizing mixture)	7.42	7.63	7.67	7.72	7.45
A^2 (LB, 70% sugar, 4 h + 1.5% appetizing mixture)	7.53	7.70	7.72	7.74	7.50
A^3 (CA, 70% sugar, 4 h + 1.5% appetizing mixture)	7.52	7.68	7.71	7.73	7.49
A^4 (LB, 70% sugar, 4 h + 2.0% appetizing mixture)	8.37	8.27	8.48	8.62	8.53
A^5 (CA, 70% sugar, 4 h + 2.0% appetizing mixture)	8.39	8.25	8.46	8.61	8.52
A^6 (LB, 70% sugar, 4 h + 2.5% appetizing mixture)	7.41	7.59	7.72	7.69	7.39
A^7 (CA, 70% sugar, 4 h + 2.5% appetizing mixture)	7.40	7.57	7.70	7.67	7.37
$CD^8_{P\geq 0.05}$	0.02	0.02	0.06	0.02	

*On 9 point hedonic scale; LB = lime juice blanching, CA = citric acid blanching

Plate 2: Osmotically dried ginger flakes

(2012) reported that the mass exchange takes place at the maximum rate within the first two hours of the osmotic treatment. About 38 per cent (fwb) of moisture was lost in first 2.0 h of drying of both lime juice and citric acid blanched ginger flakes dipped in 70 per cent sugar syrup for 4 hours, thereafter the rate of drying slowed down. Earlier, Fellows (1988) also reported that the rate of moisture loss was the slowest during falling rate of drying as compared to constant rate period. Thuwapanichayanan *et al*., (2014) also noticed that the drying of ginger slices mostly occurred in falling rate period.

Osmotic dehydration of ginger flakes after addition of appetizing mixture

The results pertaining to the sensory evaluation of osmotically dehydrated ginger flakes with different concentrations of appetizing mixture (Table 7; Plate 2) showed significantly higher mean scores for colour (8.39) for treatment A_6 (citric acid blanching, 70% sugar syrup, 4 hrs dip, rolled in 2.0% appetizing mixture) which was significantly at par with mean colour scores (8.37) of treatment A_5 (lime juice blanching, 70% sugar, 4 hrs dip, rolled in 2.0% appetizing mixture). High score for texture (8.27),

Table 8: Chemical characteristic of dried ginger appetizing flakes

Parameters	Treatment	
	A_5 (Lime blanching + 70% sugar syrup, 4 h + 2.0% #AM)	A_6 (Citric acid blanching + 70% sugar syrup, 4 h + 2.0% #AM)
	Parameters (Mean ± S E)	
Moisture (%)	12.04 ± 0.02	11.95 ± 0.03
Total soluble solid (^{o}B)	48.00 ± 0.1	48.00 ± 0.2
Titratable acidity (%)	0.19 ± 0.02	0.21 ± 0.02
pH	4.32 ± 0.01	4.27 ± 0.02
Reducing sugars (%)	7.09 ± 0.02	7.02 ± 0.01
Total sugars (%)	42.96 ± 0.03	42.55 ± 0.01
Ascorbic acid (mg/ 100g)	4.85 ± 0.05	4.91 ± 0.04
Total phenols (mg/ 100g)	10.80 ± 0.02	10.63 ± 0.03
Antioxidant activity (%)	74.02 ± 0.02	72.62 ± 0.02
Total ash (%)	1.37 ± 0.01	1.39 ± 0.02
Crude fibre (%)	1.38 ± 0.02	1.33 ± 0.03
Salt (%)	0.80 ± 0.01	0.80 ± 0.02

#AM = appetizing mixture

flavour (8.48), taste (8.62) and overall acceptability (8.53) were received by the treatment A_5. Thus, the treatment A_5 and A_6 were adjudged the best and were optimized for development of appetized ginger flakes.

Chemical characteristics of dried ginger appetizing flakes

Perusal of data in Table 8 showed that treatment A_5 and A_6 had a mean moisture content of 12.04% and 11.95 per cent, total soluble solids of 48.00 ± 0.1 ^{0}B and 48.00 ± 0.2 ^{0}B and titratable acidity of 0.19 and 0.21 per cent respectively. Further, ascorbic acid 4.85 mg/100 g and 4.91 mg/100 g, total phenol content of 10.80 mg/100 g and 10.63 mg/100 g with antioxidant activity of 74.02% and 72.62% was observed, respectively for A_5 and A_6 treatments.

Thus, on the basis of sensory evaluation and nutritional importance, the osmotically dried ginger flakes and rolled in different appetizing mixture, the treatment consisting of 1% lime juice blanching and dipping in 70 per cent sugar syrup for 4 hrs followed by 2.0% appetizing mixture rolling (A_5) was found to be the most appropriate. Further, the lime juice blanching could be replaced with citric acid blanching as the sensory scores for both the treatments were similar.

CONCLUSION

On the basis of results obtained during present studies it can be concluded that the peeled ginger blanched in 1.0 per cent lemon juice or citric acid for 15 minutes followed by dipping in 70 per cent sugar syrup for 4 hours and drying in a mechanical dehydrator (55 ± 2^{o}C) upto moisture content of 11.00 to 12.00 per cent, followed by rolling in 2.0 % appetizing mixture can be used for preparation of osmotically dried and appetized ginger flakes. The commercial adoption of this technology seems to be a profitable venture for efficient utilization of fresh ginger rhizome.

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