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Standardization of Formulation for Development of Ginger Supplemented Confectionary Products

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Abstract

Indian confectionery is one of the fastest growing sectors in the world with an estimated growth rate of 18–20% where India ranks 14th globally. Today, with modern technology and continued growing interest in these products, large companies are competing to come up with the most interesting and novel products in the market. Ginger has a long history of use as a remedy and medicinal purposes due to its therapeutic and functional properties which were harnessed for the development of ginger appetizing tablets (gingoli) and ginger fruit bar. Gingoli was prepared by the wet granulation method, where the organoleptic acceptable formulation contained 25 g ginger powder in the standardized recipe with pear pak as binding agent. The granular formulation of ginger powder had characteristics preferable for tablet formation with Carr compressibility of 12.28%, Hausner ratio 1.14 and an angle of repose as 27°. Further, among the different formulations for the development of ginger fruit appetized bar, ginger: plum 50:50 with 1.5% appetizing mixture had highest acceptability scores with the dehydration ratio observed as 3.48:1 and moisture content of 12.64%. Further, the supplementation of ginger for the preparation of ginger appetizing tablets and ginger fruit bar possessed significantly higher antioxidant activity, total phenols and crude fibre thus enhancing its functional properties and potentiality for market acceptability.

Keywords: Ginger, tablets, bar, antioxidant activity, formulation, organoleptic score

1. Introduction

Ginger (*Zingiber officinale* Roscoe) is a tropical monocotyledonous and herbaceous plant which belongs to the order Scitaminae and family Zingiberaceae (Okwuowulu, 1997). It is believed to be the native of South East Asia and is one of the important cash crop and principal spice all over the world (Purseglove et al., 1981). The total production of ginger in the world is 20, 95, 056 t from the total acreage of 3, 22,157 ha (FAO, 2015), while in India the area and production of ginger is reported to be 1,50,000 ha and 7,05,000 t, respectively (Anonymous, 2016). 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 rhizome contains over 400 different functional compounds and the major constituents are carbohydrates, lipids, terpenes and phenols (Grzanna et al., 2005) where terpene components include zingiberene, β-bisabolene, α-farnesene, β-sesquiphellandrene, and α-curcumene, while phenolic compounds include gingerol, paradols, and shogaol responsible for characteristic odour and flavour of ginger. Besides these, amino acids, fiber, ash, protein, phytosterols, vitamins (e.g., nicotinic acid, vitamin A) and minerals are also present (Langner et al., 1998; Shukla and Singh, 2007) in appreciable amounts in ginger rhizome.

Ginger is a medicinal plant that has been widely used all over the world, since antiquity, for a wide array of unrelated ailments including arthritis, cramps, rheumatism, sprains, sore throats, muscular aches, pains, constipation, vomiting, hypertension, indigestion, dementia, fever and infectious diseases (Platel and Srinivasan, 2000; Mustafa and Srivastava, 1990). Ginger rhizome is typically consumed as a fresh or processed into paste, concentrate, dried ginger (sonth) or for flavouring tea (Sambisavam and Girija, 2006). Fresh ginger are perishable in nature and are spoiled due to improper handling, growth of spoilage microorganisms, susceptibility to rhizome rot, wilting and sprouting, action of naturally occurring enzyme, chemical reactions and structural changes during storage (Baranowski, 1985). Processing ginger into novel products will not only reduce perishability but will also increase storage stability (Pezzutti and Crapiste, 1997) apart from adding new products on market shelves. Indian confectionery is one of the fastest growing sectors in the world with an estimated growth rate of 18–20% where India ranks 14th globally. The range of new fruit based confectionary products has jumped to 881 in 2003 from 232 in 1999

(Nowakowski, 2000) due to health awareness among the people.

Thus, considering the functional properties of ginger, present study was undertaken to incorporate the ginger in preparation of confectionery products so as to harness its therapeutic properties apart from reducing postharvest losses and augmenting income to growers.

2. Materials and Methods

Ginger rhizome cv. Himgiri procured from experimental farm of Dr. Y. S. Parmar University of Horticulture and Forestry were thoroughly washed, peeled, sliced (2 mm) and blanched in a solution of 1.0% citric acid (Dhiman, 2015) before drying in mechanical dehydrator (55±2 °C) to a moisture content below 10.00% (Jayashree et al., 2014). The dried slices were pulverizered into powder (Kaushal et al., 2017), sieved in 18 mesh/inch sieve and packed in polyethylene pouches for product development. The appetized ginger tablets (gingoli) were prepared by wet granulation method with varying concentrations of ginger powder (0, 5, 10, 15, 20, 25, 30 g) in the recipe (Table 1) and comparing three different binding agents whose TSS was maintained at 70 °B each.

The ingredients (Table 1) after thorough mixing were sieved in 18 mesh/inch sieve followed by drying at 55±2 °C for 2 hours to facilitate granulation. The ginger tablets were then prepared in Kambert Make 8 Station Mini Rotary Tablet Press Machine KMP-D-8 with a pressure of 9.8 kN where the weight of each tablet was adjusted to 500 mg.

Table 1: Ingredients (R) for the preparation of gingoli

Ingredients	Weight (g)
Sugar powder	30
Anardana powder	25
Mango powder (Amchoor)	5
Common salt	2
Black salt	2
Fennel powder	2
Cumin powder	2
Mint powder	2
BINDING AGENT- hypertonic sugar syrup/ gulkand/ osmotically dehydrated sand pear paste (pear pak)	18

For the preparation of ginger fruit bar, the farm procured ginger rhizome and plum fruits were utilized for pulp extraction. The ginger pulp was extracted by the hot break method after adding 30.0% water followed by heating for 60 minutes (Dhiman, 2015) and plum pulp was extracted by adding 10.0% water, heating for 15–20 minutes followed by passing the whole mass through the pulper. The pulp was preserved by heat pasteurization method (over-flow method) as advocated by Lal and Thakur (1978) and packed in pre-sterilized glass bottles for its use in product development. Ginger fruit bar was prepared by mixing ginger and plum pulp in different proportions (100:0, 90:10, 80:20, 70:30, 60:40 and 50:50) followed by homogenization and heating. The total soluble solid was raised to 25°B by exogeneous addition of cane sugar powder and the mixture was spread in a thin layer (3–6 mm) on the stainless steel trays (30×20 cm^2) with a tray load of 440 g $tray^{-1}$ and dried in a mechanical dehydrator at 55±2 °C to 13–14% moisture. The combinations of ginger plum bar were evaluated on the basis of sensory characteristics and the treatment with higher sensory score was further taken for the standardization of suitable concentration of appetizing mixture. The appetizing mixture prepared by mixing thyme seed powder (5 g); mint powder (10 g); salt (10 g) and black salt (10 g) was tried in different concentrations of 1.0, 1.5, 2.0 and 2.5%. The best treatment combination of ginger plum pulp with appetizing mixture was selected on the basis of sensory scores. Standardized ginger plum bar was cut into strips of 8 cm^2 wrapped in a butter paper and packed in laminated aluminium pouches (150 g) prior to quality evaluation.

Physico-chemical analysis of fresh and processed products was conducted by using standard analytical procedures (Ranganna, 1997, AOAC, 2004). Total phenols were extracted in 80% ethanol and were estimated using Folin-Ciocalteau reagent (AOAC, 2004). The rate of dehydration per unit time was calculated by placing a weighed quantity of ginger slices or pulp on a stainless steel tray (30×20 cm^2) followed by drying in mechanical dehydrator (55±2 °C) to a moisture content of 10–12% (w/w). Flow property of ginger powder was evaluated by using Carr compressibility (Carr, 1965) and Hausner Ratio (Hausner, 1967) and angle of repose (q) by fixed funnel method (Liu, 2011). In the funnel test, granular material was placed in a funnel and then is slowly deposited on a horizontal surface. The granular material moves over the face of the accumulated triangular pile. When the movement stops, the inclination of the pile represents the angle of repose. The inverse tangent of the ratio (height divided by half the width of the base of the pile) is the angle of repose (Liu, 2011).

The sensory evaluation of different formulations of confectionary products was done by a semi-trained panel of 7–9 judges for various quality attributes *viz*., colour, texture, flavour, taste and overall acceptability on 9 point hedonic scale for product standarization.

Data pertaining to sensory evaluation was statistically analyzed according to Randomized Block Design (RBD) as described by Mahony (1985) while, the data on chemical analysis was analyzed by following Completely Randomized Design (CRD) Cochran and Cox (1967).

3. Results and Discussion

3.1. Physico-chemical characteristics

The fresh ginger rhizome cv. Himgiri utilized for product

development contained a moisture content of 82.39% with total soluble solids as 2.7 °B (Table 2). The rhizomes were found to be a good source of total phenols (10.18 mg 100 g^{-1}), antioxidant activity (57.45%), crude protein (2.73%), crude fibre (1.41%) and total ash (1.66%). These values were in conformity with the result reported by Abeyesekera et al. (2005), Sultan et al. (2005) and Shahid and Hussain (2012). Further, the plum fruits contribute 13.86 °B total soluble solids with 2.94 per cent of acidity as malic acid, along with appreciable amount of ascorbic acid (18.30 mg 100 g^{-1}), total phenols (96.66 mg 100 g^{-1}), antioxidant activity (71.6%), crude fibre (0.07%) and total ash (0.42%) which were in agreement to the values found by Erturk et al. (2009) and Esehaghbeygi et al. (2013). Thus, keeping view the nutritional properties of ginger and plum, they were suitably blended without the addition of exogenous colour, flavour and acid.

Table 2: Quality characteristics of fresh ginger rhizome (*Zingiber officinale*) and plum fruit (*Prunus domestica*)

Characteristics	Mean±SD*	
	Ginger rhizome	Plum
Moisture (%)	82.39±0.05	86.93±0.09
TSS (°B)	2.7±0.10	13.86±0.41
Titratable acidity (% citric acid for ginger, % malic acid for plum)	0.15±0.02	2.94±0.02
pH	6.53±0.02	3.36±0.04
Total sugars (%)	1.26±0.02	9.26±0.34
Ascorbic acid (mg 100 g^{-1})	8.48±0.53	18.30±1.09
Total phenols (mg 100 g^{-1})	10.18±0.03	96.66±2.89
Antioxidant activity (%)	57.45±0.60	71.6±0.55
Crude Protein (%)	2.73±0.06	0.6±0.06
Crude fibre (%)	1.41±0.02	0.07±0.01
Total ash (%)	1.66±0.02	0.42±0.03

*All values are the mean of 10 observations

Perusal of data in Table 3 regarding physico-chemical characteristics of ginger powder (Table 3) indicated water absorption index, per cent water solubility index and bulk density of ginger powder as 0.79, 14.00% and 0.50 respectively. The water activity of ginger powder was observed as 0.356 with crude fat as 5.73% and crude protein as 6.63%. Further, the level of total phenols and antioxidant activity in ginger powder was found to be 243.86 mg 100 g^{-1} and 83.73%, respectively. The flow properties indicate that the ginger powder had a Carr compressibility of 12.28% and Hausner ratio of 1.14, which categorizes ginger powder as good while the angle of repose was observed as 27° thus putting it in excellent category according to the classification given by US Pharmacopeia (2016). Thus, the flow properties

Table 3: Physico-chemical characteristics of ginger powder (*Zingiber officinale*)

Parameters	Mean±SD*
Water absorption index	0.79±0.02
Per cent water solubility index	14.00±0.01
Bulk density (g ml^{-1})	0.50±0.01
Moisture content (%)	7.05±0.62
Water activity (aw)	0.356±0.004
Total phenols (mg 100 g^{-1})	243.86±0.06
Antioxidant activity (%)	83.73±0.04
Crude fat (%)	5.73±0.05
Crude protein (%)	6.63±0.61
Crude fibre (%)	10.11±0.03
Ash content (%)	5.33±0.03
Carr compressibility (%)	12.28 (Good)
Hausner ratio	1.14 (Good)
Angle of repose	27° (Excellent)

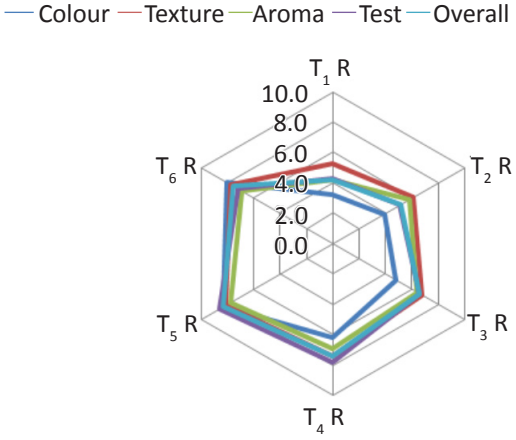
*All values are the mean of 10 observations

of ginger powder clearly shows that ginger powder has properties suitable for tablet formation

3.2. Ginger appetizing tablets (gingoli)

The tablets prepared by using different concentrations of ginger powder (0–30%) with a pre-standardized recipe (R) bound with hypertonic sugar solution were subjected to sensory evaluation to find out the most palatable formulation.

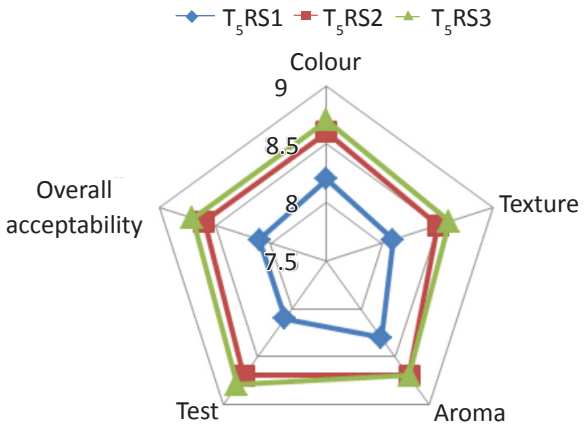
Among the different combinations, significantly higher scores for colour, texture, aroma, taste and overall acceptability were scored by treatment combination T_5R *viz*., 25 g ginger powder in the recipe R (Figure 1). On further screening of



T_1: 5 g, T_2: 10 g, T_3: 15 g, T_4: 20 g, T_5: 25 g, T_6: 30 g ginger powder in recipe R

Figure 1: Sensory scores of ginger appetizing tablets with varying ginger concentration

binding agents (Figure 2) the tablet bound by gulkand (70 °B) and pear pak (70 °B) were preferred over hypertonic sugar solution (70 °B) by the panelists with an overall acceptability scores of 8.3 and 8.7 respectively. This may be due to the presence of inherent biological content as fibre, sugar, phenols and vitamins etc. thus facilitating good compaction. Tavakoli et al. (2008) also reported that the type and amount of binders decisively influences the characteristics of the tablets prepared by wet granulation procedure. Thus a formulation having 25 g ginger powder in recipe R with pear pak as binding agent has been optimized and packed in aluminium laminated pouches for quality evaluation.



S_1: Hypertonic sugar solution; S_2: Gulkand; S_3: pear pak

Figure 2: Sensory scores of ginger appetizing tablets with different binding agents

3.3. Quality characteristics of ginger appetizing tablets (gingoli)

Data from the organoleptic evaluation clearly shows that 25 g ginger powder in recipe R (Table 4) binded with pear par (osmotically dehydrated sand pear paste) was liked by the panelists. Nutritionally the tablet contained 188.16 mg 100 g^{-1} of total phenols, 89.76% of antioxidant activity, 7.44% crude fibre and 6.11% ash content with a water activity of 0.361.

3.4. Ginger plum bar

Among the different pulp combinations, significantly higher scores for colour (8.25), texture (8.20), flavour (7.99), taste (8.00) and overall acceptability (8.50) was received by ginger: plum 50:50 proportion (Table 5). The bar prepared by using 100% ginger was rated as least preferred with colour, texture, flavour, taste and overall acceptability scores of 5.16, 5.07, 5.21, 5.81 and 5.11 respectively with unacceptable pungency and further could not form into bar.

Table 4: Physico-chemical characteristics of ginger appetizing tablets

Parameters	Mean
Water activity (aw)	0.361±0.002
Titratable acidity (%)	0.29±0.04
Total phenols (mg 100 g^{-1})	188.16±0.91
Antioxidant activity (%)	89.76±0.79
Crude fibre (%)	7.44±0.12
Ash content (%)	6.11±0.05

Table 5: Sensory evaluation of recipes for the preparation of ginger plum bar

Treatments	Plum: ginger ratio	Colour	Texture	Flavour	Taste	Overall acceptability
T_1	100:0	7.98	7.80	7.59	7.59	7.78
T_2	90:10	8.10	7.82	7.62	7.62	7.87
T_3	80:20	8.14	7.87	7.68	7.78	7.89
T_4	70:30	8.16	7.98	7.76	7.81	7.92
T_5	60:40	8.20	8.16	7.92	7.91	8.00
T_6	50:50	8.25	8.20	7.99	8.00	8.50
T_7	0:100	5.16	5.07	5.21	5.81	5.11
CD (p=0.05)	0.04	0.03	0.02	0.08	0.03	

3.5. Drying behaviour

It took about 8.00 to 9.30 hours to dry the pulp combination to moisture content of about 13.04 to 13.93% (Table 6). The dehydration ratio varied between 3.48:1 to 3.91:1 and the maximum yield (28.76%) was noticed in 50:50 proportion and time taken for drying was 9.30 hours.

Table 6: Drying characteristics of ginger plum pulp formulation

Treatments	Plum: ginger pulp	DT	Yield (%)	Dehydration ratio	TS	Moisture (%)
T_1	100: 0	8.00	27.10	3.91: 1	86.07	13.93
T_2	90: 10	8.10	27.23	3.67 :1	86.37	13.63
T_3	80: 20	8.35	27.55	3.63: 1	86.59	13.41
T_4	70: 30	8.55	28.21	3.55: 1	86.72	13.28
T_5	60: 40	9.15	28.70	3.48: 1	86.89	13.15
T_6	50: 50	9.30	28.76	3.48: 1	86.99	13.04

DT: Drying time (hrs); TS: Total solids (%)

To workout the optimum concentration of appetizing mixture in the standardized pulp combination, results in Table 7 showed that plum: ginger 50:50 with 1.5% appetizing mixture scored higher scores for colour (7.40), texture (8.16), flavour (7.90), taste (7.97) and overall acceptability (8.46) among all combinations.

3.6. Quality characteristics of ginger plum bar

The data presented in Table 7 shows that the appetized ginger plum bar contains slightly higher amount of ascorbic acid (13.16 mg 100 g^{-1}), phenols (55.89 mg 100 g^{-1}), antioxidant activity (72.94%) as compared to bar without appetizing mixture. Thus, the appetizing mixture (1.5%) adds additional value to ginger plum bar.

Table 7: Effect of different concentrations of appetizing mixture on sensory quality of spiced plum ginger leather

Treatments	Plum: ginger+ *AM (%)	Colour	Texture	Flavour	Taste	Overall Acceptability
TA_1	50:50+1.0	7.36	7.94	7.86	7.88	7.62
TA_2	50:50+1.5	7.40	8.16	7.90	7.97	8.46
TA_3	50:50+2.0	7.18	7.68	7.68	7.58	7.58
TA_4	50:50+2.5	7.13	7.62	7.64	7.47	7.42
CD (p=0.05)	0.03	0.02	0.05	0.14	0.08	

*AM: Appetizing mixture

4. Conclusion

Ginger possessing substantial nutritional properties can successfully be utilized for the preparation of ginger appetizing tablets and fruit bar. The ginger supplementation not only enhanced the nutritional value of the confectionary products but also created novel products for the market. Thus, the commercial adoption of this technology seems to be a profitable venture for utilization of ginger thereby augmenting the income of ginger growers with minimum postharvest losses.

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