

Original Research Article

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Development and Characterization of Functional Ginger Powder Tablets

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ABSTRACT

Keywords

Ginger powder, Tablets, carr compressibility, Hausner ratio, Antioxidant activity

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Ginger powder with high antioxidant activity, phenols, crude fibre and ash content was utilized for the preparation of ginger appetizing functional tablets. The flow properties of ginger powder categorized it good on the basis of carr compressibility (12.28%) and hausner ratio (1:1.14) and excellent (27°) on the basis of angle of repose. The tablets were prepared by wet granulation method with varying concentrations of ginger powder (5g to 30g) using gulkand as natural binding agent and hypertonic sugar syrup. On the basis of sensory evaluation the gulkand bound granulated tablets containing 25g of ginger powder found most acceptable. The granular formulation of tablets had Carr compressibility 19.19 per cent and Hausner ratio 1.25 when bound with gulkand. On the basis of angle of repose, the granules were found excellent for the preparation of tablets. The ginger appetizing tablets showed significantly higher antioxidant activity, total phenols, total ash as minerals and crude fibre in tablets.

Introduction

Ginger (*Zingiber officinale Roscoe.*) 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 (Ali *et al.*, 2008; Platel and Srinivasan, 2000; Mustafa and Srivastava, 1990). It is one of the most important cash crop and principal spice of India. India being the largest producer and exporter of ginger to more than 50 countries, particularly to the Middle East, accounting for more than 70% of the world production (Pruthi, 1993). Ginger is

valued due to the aromatic compounds giving a spicy, pungent and pleasant flavor (Bartley and Jacobs, 2000). Ginger bread, confectionery, ginger ale, curry powders, table sauces, pickling and certain soft drinks like cordials, ginger cocktail, carbonated drinks are some of the value added products of ginger; apart from the extraction of ginger oil, oleoresin, essences, tinctures etc. (Maizura *et al.*, 2011). The ginger powder can be utilized for development of different commercial products like cookies, candy, tea, tinctures, sodas, jam, beer and syrup (Govindarajan, 1982).

Depending upon the prevailing demand, ginger rhizome is harvested after six months

of sowing for value addition and consumption due to its tenderness and presence of low fibre content. However, fresh ginger rhizome is perishable in nature and gets spoiled due to improper handling, growth of spoilage microorganism, action of naturally occurring enzymes, chemical reactions and structural changes during storage due to its high moisture content (Sagar and Kumar, 2009). Thus, dehydration of ginger is therefore a low cost method which can be implemented to reduce the post harvest losses with minimal changes in its physical, chemical and organoleptic properties (Kubra and Rao, 2012) due to reduced water activity. Further, in food industry, application of compaction is at developing stages, where compaction of powder into tablets is an excellent alternate for overcoming problems associated with post-processing handling, packaging and storage of fruit and vegetable powders. Powder in tablet form becomes less hygroscopic due to reduction of surface area which facilitates in reducing packaging cost. The present study was therefore designed to develop and evaluate palatable formulation using ginger powder and other spices into an appetizing tablet form.

Materials and Methods

Raw material

The fresh ginger rhizome (cv. Himgiri) harvested at optimum maturity from the Department of Seed Science and Technology, UHF, Nauni, Solan Himachal Pradesh was used for powder preparation. The rhizomes after washing were peeled mechanically, sliced (approximately 2mm thickness) and blanched in solution of 1.0 per cent citric acid (Dhiman, 2015) followed by drying in mechanical dehydrator at $55\pm 2^{\circ}$ C till the moisture content of slices reached below 10.00 cent (Jayshree *et al.*, 2014). The dried slices were powdered into a pulverizer, sieved

in 18 mesh/inch (1.04mm) mesh for product development. Other ingredients like common salt, black salt, mint, cumin powder, fennel powder, gulkand etc. for the formulation of tablets were procured from the local market. The fresh mint leaves were washed, dried in a vacuum drier and grounded into powder.

Preparation of tablets

The tablets were prepared by wet granulation method which involved binding of dry primary powder particles using a granulating fluid. The hypertonic sugar syrup and gulkand were used as binding agents and the TSS was maintained at 70°B each. The procedure involved mixing of all the ingredients listed in Table 1 except black salt and common salt with varying concentrations of ginger powder from 0, 5, 10, 15, 20, 25, 30 g and bound with gulkand as well as hypertonic sugar syrup to form the coherent mass. The mass was sieved through 18 mesh/inch (1.04 mm) sieve and dried at $55\pm 2^{\circ}$ C for two hours, granulated followed by addition of black and common salt.

The said powder was compacted in Kambert Make 8 Station Mini Rotary Tablet Press Machine D tooling with a pressure of 9.8 kN without pre-compression with 8 sets and 6 numbers dummy dies model KMP-D-8. The weight of each tablet was adjusted to 500 mg. The prepared tablets were packed in aluminium laminated pouches containing 6 numbers of tablets in each pack.

Analysis

Physico-chemical analysis of ginger powder and formulated tablets were conducted by using standard analytical procedures. Total soluble solid (TSS) content was determined by hand refractometer while, sugars were estimated by Lane and Eyon, 1923 method. Acidity was determined by titrating the

aliquots against a standardized 0.1 N NaOH solution to a pink end point using phenolphthalein as an indicator (Ranganna, 2009). Total phenols were extracted in 80% ethanol and were estimated using Folin-Ciocalteu reagent as per standard procedure (AOAC, 2004). The compaction properties like bulk density (g/ml) and tapped density (g/ml) of the ginger was estimated by the standard procedures. Further, flow property of ginger powder and tablet formulation was evaluated by using Carr compressibility (Carr, 1965) and Hausner Ratio (Hausner, 1967) with the following formula:

Carr compressibility (%) =

$$\frac{\text{Tapped density} - \text{Bulk density}}{\text{Tapped density}} \times 100$$

Hausner ratio (HR) = Tapped density/ Bulk density

Angle of repose which is related to the density, surface area, shapes of the particles and the coefficient of friction of the material is calculated by fixed funnel method of Liu (2011) with the following formula.

$$\text{Angle of repose } (\theta) = \tan^{-1} h/r$$

where, h=height of pile, r = radius of base of pile

Water absorption index (WAI) was determined as described by Anderson (1969) where 1 g of the ginger powder was suspended in 12 mL of distilled water at ambient temperature in a tared centrifuge tube where the suspension was stirred in a vortex mixer for 1 minute, shaken for 30 minutes and then centrifuged in a Hermle centrifuge; model Z383 at 3500 rpm for 10 minutes. The liquid supernatant was carefully transferred into a tared evaporating dish and dried at 110°C to

constant weight. The weight of the remaining gel was taken as WAI and expressed in g/g.

WAI=

$$\frac{\text{Weight of wet solid remaining after centrifugation}}{\text{Weight of initial dry sample}}$$

The amount of dried solids, recovered by evaporating the supernatant from the WAI was used for measuring per cent water solubility index (WSI).

Per cent WSI =

$$\frac{\text{Weight of dry solids after centrifugation}}{\text{Weight of initial dry sample}} \times 100$$

Water activity was estimated by Computer Digital Water Activity Meter (HW₃ model, Rotronic International, Switzerland), where direct measurements were taken at room temperature. Standard cuvette was used in which products and powder were filled upto the brim and placed below the sensor of the water activity meter, which gave direct reading of water activity of the samples.

For determining the equilibrium relative humidity (ERH) 5 g of sample was spread evenly on tared petri dishes which were then placed inside the desiccators containing H₂SO₄ solutions of varying concentrations representing relative humidity levels ranging between 0-100 per cent. The loss or gain in weight of sample was recorded at 24 hours till the samples attained the equilibrium. After equilibrium, data were plotted against relative humidity to determine ERH of given samples (Ranganna, 2009). Critical and danger points of different products were evaluated according to the weight equilibrium method of Wink (1946).

For standardization of palatable formulation of tablets, the tablets were served for evaluation to a panel of 7–9 semi-trained judges for various quality attributes viz., colour, taste, flavour, body and overall acceptability on 9 point hedonic scale. The data pertaining to sensory evaluation were analyzed according to Randomized Block Design (RBD) as described by Mahony (1985) while, the data on chemical characteristics were analyzed statistically by following Completely Randomized Design (CRD) according to Cochran and Cox (1967).

Results and Discussion

Physico-chemical properties of ginger powder

The ginger powder under study had a moisture content of 7.05 ± 0.62 percent with water activity of 0.356 ± 0.004 and water absorption index and per cent water solubility index as 0.79 ± 0.02 and 14.00 ± 0.01 per cent respectively which was near to the values revealed by Phoungchandang and Sertwasana (2010) and Nakade *et al.*, (2014). The per cent crude fat and per cent crude protein in ginger powder was calculated as 5.73 ± 0.05 and 6.63 ± 0.61 respectively (Table 2). Further the presence of high phenols (243.86 ± 0.06 mg/100g) and appreciable antioxidant activity (83.73 ± 0.04 %) highlighted its nutritional significance. A high amount of ash content (5.33 ± 0.03 %) further emphasized its rich mineral composition.

Flow properties of ginger powder

Data pertaining to the flow properties of ginger powder presented in Table 3 elucidate that the powder had a Carr compressibility of 12.28 per cent and Hausner ratio of 1.14 with a bulk density and tapped density as 0.50 g/ml and 0.57 g/ml respectively. The angle of repose calculated by fixed funnel method was

found 27° and categorized in excellent flow able powder according to the classification given by US Pharmacopeia (2016). Thus, the excellent flow behavior of ginger powder predicted from carr compressibility, hausner ratio and angle of repose indicated that the powder was well suited to be compressed into tablets.

Standardization of formulation for the preparation of ginger powder based tablets

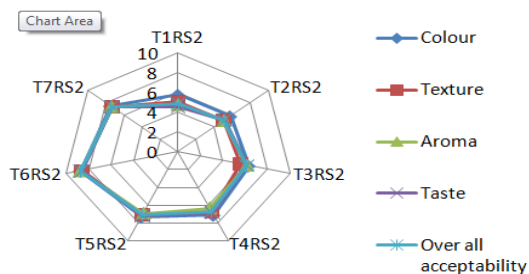
The tablets prepared by using different concentrations of ginger powder from (5,10,15,20,25,30g) with a pre-standardized recipe (Table 1) and varying binding agents (gulkand and sugar syrup) were subjected to sensory evaluation to screen the most palatable formulation. The results showed that significantly higher scores for colour, texture, aroma, taste and overall acceptability were scored by treatment combination 25 g ginger powder in recipe R and gulkand as binding agent (T₆RS₂). Lower concentrations of ginger powder in the formulation was not liked by the panelists due to less preferable taste while high amount of ginger powder in the formulation was rejected due to increased pungency of ginger powder in the tablet. The type and amount of binders decisively influences the characteristics of the tablets prepared by wet granulation procedure (Tavakoli *et al.*, 2008). Thus, a formulation having 25g ginger powder in recipe R with gulkand as binding agent was optimized for further experimentation.

Pre-compression flow properties of tablet formulation (granules)

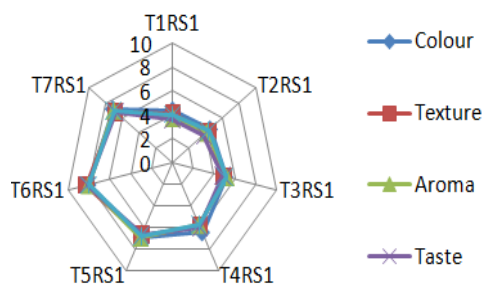
After screening the concentration of ginger with the prestandardized recipe and gulkand as binding agent (T₅RS₂), the granular formulation was subjected to analysis of various flow characteristics before compaction into tablets by wet granulation so

as to study its suitability for preparation of tablets. The formulation had Carr compressibility of 18.72 per cent and Hausner ratio 1.23 calculated from bulk density (0.625g/ml) and tapped density (0.761g/ml). Thus, according to US Pharmacopeia (2016)

these characteristics categorize the granules under the category of fair while the angle of repose categorized the granules as good with values of 32° thus found suitable for the preparation of good quality tablets.



Ginger tablets (gulkand- S2)



Ginger tablets (sugar syrup-S1)

T1-Control (without ginger); T2-5g; T3-10g; T4-15g; T5-20g; T6-25g; T7-30g ginger powder; R- recipe

Table.1 Ingredients (R) for the preparation of ginger appetizing tablets

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
Gulkand/ Hypertonic sugar syrup	18

Table.2 Physico-chemical characteristics of ginger powder

S. No.	Parameters	Ginger Powder Mean±SD
1	Moisture content (%)	7.05 ± 0.62
2	Water activity (a _w)	0.356 ± 0.004
3	Water absorption index	0.79 ± 0.02
4	Per cent water solubility index	14.00 ± 0.01
5.	Total phenols (mg/100g)	243.86 ± 0.06
6.	Antioxidant activity (%)	83.73± 0.04
7.	Crude fat (%)	5.73 ± 0.05
8.	Crude protein (%)	6.63 ± 0.61
9.	Crude fibre (%)	10.11 ± 0.03
10.	Ash content (%)	5.33 ± 0.03

Table.3 Physical evaluation parameters of ginger powder

S. No.	Parameters	Ginger Powder
1	Bulk density (g/ml)	0.50
2	Tapped density (g/ml)	0.57
3	Angle of repose	27° (Excellent)
4	Carr compressibility (%)	12.28 (Good)
5	Hausner ratio	1.14 (Good)

Table.4 Nutritional characteristics of ginger tablets

Sr. No.	Parameter	Ginger tablets
1	Moisture content (%)	1.97 ± 0.27
2	Water activity (a _w)	0.373 ± 0.003
3	Titrateable acidity (% citric acid)	0.32 ± 0.02
4	Total phenols (mg/100g)	167.26 ± 0.09
5	Antioxidant activity (%)	84.30 ± 0.11
6	Crude fibre (%)	6.53 ± 0.07
7	Ash content (%)	6.72 ± 0.04

Physico-chemical characteristics of ginger powder based tablets

On the basis organoleptic quality and compaction properties, 25.0 percent ginger powder in recipe R and gulkand (70^oB) as binding agent was standardized and was subjected to physiochemical characteristics. The data in the Table 4 elucidate that the standardized tablets had a water activity of 0.373 ± 0.003 with a moisture content of 1.97 ± 0.27 and a titratable acidity of 0.32 ± 0.02 per cent citric acid. Nutritionally, the tablet contained a huge amount of total phenols (167.26 ± 0.09 mg/100g), antioxidant activity (84.30 ± 0.11 %), crude fibre (6.53 ± 0.07 %) and ash (6.72 ± 0.04 %) content thereby highlighting the significance of addition of ginger in the appetizing tablets.

The present investigation concludes that the ginger powder possessing appreciable nutritional properties and can successfully be utilized for the preparation of tablets. The ginger powder supplemented tablets with high total phenols and antioxidant activity highlighting the significance of addition of ginger in the appetizing tablets. The technology helps in developing nutritionally rich novel product for the market, thereby generating new income source among farmers which can further boost entrepreneurship development.

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