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Dashrath Bhati
Post Doctoral Fellow, Department of Food and Nutrition, College of Home Science, GB Pant University of Agriculture and Technology, Pantnagar, Uttarakhand, India

Rita Singh Raghuvanshi
Professor, Department of Food and Nutrition, College of Home Science, GB Pant University of Agriculture and Technology, Pantnagar, Uttarakhand, India

Corresponding Author:
Dashrath Bhati
Post Doctoral Fellow, Department of Food and Nutrition, College of Home Science, GB Pant University of Agriculture and Technology, Pantnagar, Uttarakhand, India

Nutritional analysis of raw and processed ginger and its products

Dashrath Bhati and Rita Singh Raghuvanshi

Abstract
The object of present study was to estimate the nutrient composition of tender ginger, mature ginger, ginger candy, ginger sherbet, ginger precipitate obtained while processing of ginger sherbet. Present study reveals that mature ginger had higher in ash (7.48 %), fat (4.48%), crude fiber (9.75%) and protein (10.54%) content on dry weight bases. However tender ginger had similar content of ash and fat i.e. 3.80%. Carbohydrate content was noted maximum in tender ginger. Among the processed products ginger candy noted 1.68 % of crude fiber. Ginger sherbet was prepared by dilution and hence its significant impact on the nutrient composition was observed. Ginger precipitate was collected while the processing of ginger for juice and noted that it had 7.04 % protein and 3.80% of ash content.

Keywords: Ginger, processing, nutritional quality, ginger precipitate, ginger candy & sherbet

Introduction
Ginger belongs to Zingiberaceae family and an English botanist William Roscoe (1753-1831) gave this plant the name Zingiber officinale in the year 1807. It is an oldest rhizome widely domesticated as a spice where the edible part is the swollen underground stem or rhizome. The Zingiberaceous plants have strong aromatic and medicinal properties and are characterized by their tuberous or non-tuberous rhizomes (Chen *et al*. 2008). Ginger is valued as a spice because of its aroma and pungency (Paull *et al*. 1988) and has been used through ages in almost all systems of medicine against many maladies due to its medicinal properties (Kubra and Rao 2012). Despite of its use as flavoring agent, ginger is also appreciated in ayurvedic, tibbe-e-unani (Srivastava and Mustafa 1989), allopathic (Fessenden *et al*. 2001), aromapethy (Shelly *et al*. 2004) and household medicines (Sloand and Vessey 2001). Ginger rhizome can be employed in the form of fresh paste, ginger tea (flavoring), dried powder and preserved slices (El-Ghorab *et al*., 2010).
Traditional systems of medicine of several Asian countries have been using plant as a source of medicines for general well-beings (Afzal *et al*., 2001) [1]. Nowadays, considerable interest is being generated in nutraceuticals because of their potential nutritional, safety, and therapeutic effects with no/less side effects, as compared to modern system of medicine. Hence investigation on various nutritional components is important, especially the level change of nutrients caused by processing (Hirasa and Takemasa, 1998) [7]. Cooking or application of heat during primary or secondary processing and leads positive or negative changes in the nutrient compositions, including minerals and antioxidant (Miglio *et al*., 2007; Bernhardt and Schlich 2006) [10, 4]. Information on the macro nutrient and its retentions in ginger is limited. Therefore, present study was conducted on the nutritional composition of tender ginger, mature ginger, ginger candy, ginger sherbet and ginger precipitate (obtained after extraction of the ginger juice).

Material and Methods
On the bases of visual inspection two types of fresh ginger i.e. tender ginger and mature ginger was purchased from the local market of the Pantnagar. Different permutation and combinations were employed for formulation of sweet ginger products. After standardization and sensory evaluation two ginger products i.e. ginger candy and ginger juice were finalized for nutritional quality evaluation. While processing of ginger for juice, after adding citric acid in ginger extract and got precipitated. The tender ginger, mature ginger, ginger candy, ginger sherbet and ginger precipitate were analysed for the following parameters were evaluated:

Proximate Composition
All the developed ginger products were analysed for the proximate composition- i.e. moisture, protein (N x 6.25), crude fat (ether extraction), ash and crude fibre (AOAC, 1999). The

carbohydrate, content was calculated by difference, i.e. 100, the sum of the per cent of ash, protein, fat and fibre (AOAC, 1999). Energy value was calculated by multiplying the physiological values obtained for carbohydrate, protein and fat, with 4, 4 and 9 respectively and adding up the values (AOAC, 1999).

Mineral content

All the developed ginger products were analysed for calcium, iron, zinc, magnesium, manganese, and chromium content through Atomic Absorption Spectrophotometer method suggested by Bishnoi and Brar, 1988.

Antioxidant analyses

The tender ginger, mature ginger, ginger candy, ginger sherbet and precipitate were analysed for following antioxidants:

Total phenolics content: The total phenolic content was determined using the Folin-Ciocalteu assay according to procedure describe by Dewanto *et al*. (2002) [6] with slightly modification and the results were expressed as mg gallic acid/g. An aliquot of 1 ml of the methanol extract of test sample was mixed with 1 ml of the Folin-Ciocalteu reagent and 4 ml of a 20 % sodium carbonate solution. Distilled water was added to a final volume of 25 ml. Following incubation for 30 min, the absorbance of the reaction mixture was measured at 765 nm using spectrophotometer against a blank. Gallic acid was used as the standard. The amount of total phenolic was calculated by using the standard curve of Gallic acid drawn within a concentration range of 8.0×10^{-4} to 4.0×10^{-3} mg/ml having R2 value 0.996 and was expressed as mg/ Gallic acid equivalents g (mg /GAE g).

Flavonoid content: The flavonoid content of the samples were extract in methanol and was determined using aluminium trichloride method protocol described by Chang *et al*. (2002) [5] with slightly modification. Briefly, 2 ml of 2 % aluminium trichloride solution in methanol was mixed with the 2 ml of a diluted stock solution (0.01 or 0.02 mg/ml). Absorption readings were taken at 415 nm spectrophotometer after 10 min against a methanol blank, Quercetin was used as the standard. The total flavonoid content was determined using a standard curve of Quercetin drawn within a concentration range of 4.0×10^{-3} to 2.0×10^{-2} mg/ml having R2 value 0.998 and was expressed as mg Quercetin equivalents/g (mg QE/g)

DPPH assay: DPPH (2,2- diphenyl-1-picryl-hydrazyl) is a free radical, and produces a violet solution in alcohol. It is reduced in the presence of an antioxidant molecule. Antioxidant activity of the methanol extract of test sample and standard were assessed on the basis of the radical scavenging effect of the DPPH. The diluted working solutions of the test samples were prepared in methanol. Gallic acid was used as the standard in solutions ranging from 5×10^{-4} to 4×10^{-3} mg/ml. 0.135 mM DPPH solution was prepared in methanol. Then 2 ml of this DPPH solution was mixed with 2 ml of sample solutions (ranging from 1 mg/ml to 8 mg/ml) and the standard solution were tested separately. These solution mixtures were kept in the dark for 30 min and optical density was measured at 517 nm using spectrophotometer. The 2 ml of methanol with 2 ml of DPPH solution was used as control. The optical density was recorded and percentage of inhibition was calculated using the formula given below:

% of inhibition of DPPH activity = (A -B/A) x 100.

Where, A is optical density of the control and B is optical density of the sample. The IC50 values were calculated using linear regression of plots.

Result and Discussion

Proximate composition

The data of chemical composition of tender ginger, mature ginger, ginger juice, ginger candy and ginger precipitate are presented in Table 1. The chemical composition of tender ginger was found as moisture 93. 40%, ash 3.80%, protein 2.65%, fat 3.80%, crude fiber 7.30%, and energy 338.80 kcal on dry weight bases. Results of present study revealed that with increase in maturity stage of ginger the moisture content and carbohydrate content was decreased. However, crude fiber, ach, crude fat and protein content were trend of increase. Khan *et al*., (2016) [8] anlysed powdered ginger also has nutritional components i.e. fatty oil (3–6%), protein (9%), carbohydrates (60–70%), crude fiber (3–8%), and about 8% ash. Whereas ginger candy was shown to contain 5.88 % moisture. Alam *et al*., 2018 prepared ginger candy and observed moisture 7.04%, ash 0.78 %, fat 0.18%, fiber 1.60 % and protein 2.78.

Ginger precipitate was obtained after adding citric acid in the extract of ginger while its processing for juice. This precipitate was also analysed and observed that it contained higher amount of protein (7.04%) and ash (5.67%). This precipitate could be utilized for the coating of candy as it was observed hygroscopic in nature.

Table 1: Proximate composition of ginger and its products (%/100gm)

	Moisture	Ash	Fat	Fiber	Protein	CHO	Energy (Kcal)
Tender Ginger	93.40 ± 0.034	3.80 ± 0.014	3.80 ± 0.151	7.30 ± 0.058	2.65 ± 0.043	73.49 ± 0.195	338.80 ± 0.653
Mature Ginger	90.60 ± 0.126	7.48 ± 0.218	4.48 ± 0.099	9.75 ± 0.547	10.54 ± 0.113	67.75 ± 0.731	353.47 ± 1.781
Candy	5.88 ± 0.399	0.39 ± 0.013	3.96 ± 0.099	1.68 ± 0.107	0.55 ± 0.102	93.42 ±0.126	411.53 ± 0.918
Sherbet	41.86 ± 0.202	0.02 ± 0.002	0.03 ± 0.002	0.04 ± 0.002	0.19 ± 0.022	99.71 ± 0.022	399.95 ± 0.014
Precipitated residue/Salt	9.37 ± 0.202	5.67 ± 0.121	0.07 ± 0.007	0.53 ± 0.011	7.04 ± 0.217	86.69 ± 0.352	375.59 ± 0.491

*dry weight bases.

Mineral Content

The mineral composition of the tender ginger, mature ginger, ginger candy, ginger sherbet and ginger precipitate were estimated for calcium, magnesium, manganese, iron, zinc and chromium (table 2). The tender ginger noted higher for magnesium, manganese, iron and zinc content as compare to mature ginger. The iron and zinc content of the candy was noted 2.14 mg/100gm and 1.89 mg/ 100gm. All the analysed minerals were found maximum in ginger candy as compared to sherbet and ginger precipitate. The mineral and nutritional composition varies with the type, variety, agronomic conditions and various other processing and storage conditions (Agrahari, 2015) [2].

Table 2: Mineral composition of the ginger and its products (mg/100gm)

	Calcium	Magnesium	Manganese	Iron	Zinc	Chromium
Tender Ginger	9.76±1.196	196.40±0.524	22.81±0.255	32.10±1.223	8.06±0.119	0.23±0.013
Mature Ginger	12.14±0.435	121.04±1.058	7.63±0.434	19.62±0.084	3.07±0.054	0.33±0.003
Candy	5.94±0.385	27.30±0.428	4.29±0.026	2.14±0.177	1.89±0.059	0.37±0.054
Sherbet	0.62±0.076	5.54±0.660	0.32±0.058	0.55±0.068	0.31±0.025	0.06±0.010
Precipitated residue/ Salt	2.10±0.054	10.21±0.741	0.83±0.031	3.01±0.237	1.31±0.112	0.28±0.015

*dry weight bases

Antioxidant Analyses

The results for samples i.e. tender ginger, mature ginger, ginger candy, ginger sherbet and precipitate were analysed for total phenolic, flavonoids and DPPH assay and presented under the table 3. Total phenolics content was observed higher in mature ginger (5.53 mg GAE/g) followed by ginger precipitate (4.90 mg GAE/g) and tender ginger (3.09 mg GAE/g). The flavonoid content in the test samples were extract in methanol and ranged between 0.19 to 0.74 QE/g in ginger sherbet and tender ginger respectively. The (DPPH) radical scavenging activity with the IC50 value in tender ginger was 0.74 mg/mL followed by mature ginger (0.58 mg/100gm) and candy 0.39mg/g.

Li *et al* (2016) [9] studied total phenolic content in fresh ginger and noted 8.46 mg GAE/g. Mukherjee and co-worker (2014) [11] studied total phenolic content by using response surface methodology and concluded that solvent concentration, temperature and time had the most significant effect on the extraction rate of polyphenols.

Table 3: Antioxidants present in the ginger and its by products

	Total polyphenol (GAE mg/g)	Flavanoid (QE/g)	DPPH (IC_{50}) mg/ml
Tender Ginger	3.0	0.74	19.28
Mature Ginger	5.53	0.58	7.29
Candy	0.22	0.39	8.71
Sherbet	0.11	0.19	9.37
Precipitated residue/ Salt	4.90	0.198	168.76

Conclusion

The present study reveals that the processed products of ginger could be the best alternative to provide mineral rich candy. Ginger precipitated obtained after adding citric acid in the ginger extract was also found rich in minerals, protein content. The precipitate was rich in antioxidant content and could be utilized as coating agent of ginger candy. Processing of ginger and its dilutions affect the nutrient content in the end product.

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