Ginger (Zingiber officinale) powder from low temperature drying technique

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Abstract

Ginger (Zingiber officinale) powder was prepared using different low temperature drying techniques and their nutritional, phytochemicals, functional and sensory quality were investigated. Moisture content was significantly (p<0.05) higher (7.16±0.04%) in shade dried powder and lowest in oven dried powder. Protein, fat and fiber contents varied with drying techniques ranging from 6.08±0.05 to 6.68±0.07%, 1.08±0.16 to 1.39±0.25% and 3.86±0.13 to 5.11±0.06% respectively. Highest alkaloid content was found in mechanical dried powder (4.44±0.04%), while highest flavonoid content was found in oven dried ginger powder (4.67±0.07%) and maximum saponin content was recorded in shade dried powder (2.67±0.10%). Highest ascorbic acid content (3.53±0.08 mg/100g) was found in shade dried powder and lowest was recorded in oven dried ginger powder (3.53±0.08 mg/100g). Sun drying technique exhibited better nutritional and sensory quality. The sensory score demonstrated acceptance of all dried ginger powder was in the range of liked very much to liked moderately by the panelist. Low temperature drying techniques have positive significance on retaining phytochemicals and sensory quality of processed ginger.

Keywords: Drying techniques; Nutritional composition; Functional property; Mineral content; Sensory quality

Introduction

Ginger (Zingiber officinale) is a herbaceous perennial flowering plant belongs to the Zingiberaceae family. Traditionally it is known as oldest spice and used as folk medicine. This plant is used around the whole world in food as a spice in dried and fresh conditions for enhancing the flavor, make spicy and pungency taste to the meal (Jayashree and Viswanathan, 2011). It is a good source of minerals and vitamins (i.e. β-carotene, ascorbic acid). This plant used as food masala (i.e. pickles, cookies, marmalade) in confectionery, seasoning and flavoring material in diet, bakery products and alcoholic and non-alcoholic beverage (Plotto, 2002). Fresh ginger is a perishable spice causes of improper postharvest management and changes in micro constituent for chemical reaction during storage time. Postharvest management of ginger is not well developed (Pruthi, 1993). But, it is important to explore alternative techniques for processing fresh ginger industrially. Drying is the alternative techniques for producing ginger powder and allows them to use in off-season. Dried powder is a substitute product of fresh ginger and stored for long time holding its

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freshness. It takes small space and lighter in weight rather than raw ginger. For longer shelf life, the dried powder can be an effective solution for processors to make it as a commercial product. It can also be considered as processed product for ready to use in restaurants and homes (Ahmed and Shivhare, 2001). Moreover, dried ginger powder is less prone to microbial contamination (Prasad et al., 2006). There are different drying techniques including sun drying, microwave drying, vacuum drying, freeze drying etc. (Jayashree et al., 2014). The drying techniques can affect the phytochemicals, flavor and color of processed powder. For this, it is an important factor to maintain optimal temperature and rational heat dosage (Figiel, 2010). For producing ginger powder, low temperature drying techniques can be effective for retaining color, flavor, phytochemicals and nutritional contents. Therefore, the objective of this study was to evaluate the nutritional, functional and sensorial quality of low temperature dried ginger powder.

Ginger powder preparation

Collected ginger rhizomes were washed with running tap water. For improving the shelf life, gingers were cut into 2-5 mm slices and dehydrated using the following four different drying techniques.

i. Sun drying (SD) - sliced ginger were dehydrated in hot sunlight.

ii. Oven drying (OD) - sliced ginger were dehydrated at (50 ±5) °C for 6-8 hours.

iii. Mechanical drying (MD)- sliced ginger were dehydrated in hot air mechanical dryer.

iv. Shade drying (SHD) - sliced ginger was dehydrated in shade maintaining room temperature.

Dehydrated ginger slices were ground using a grinder for making fine powder as shown in Fig. 1. Prepared ginger powder was stored at 4°C in low dense airtight polyethylene bag for further analysis. Chemically color cleaned ginger were blanching and soaking into boiling water for 10-15sec. Then immersed in 0.2% potassium metabisulphite (KMS) solution for 5 min at room temperature (Singh et al., 1997).

Methods of analysis

All experiment parameters were conducted at ambient temperature and repeated three times. Nutritional composition (i.e. moisture, ash, crude fat, protein and crude fiber) of dried ginger powder were estimated following AOAC methods (AOAC, 2005). Digestible carbohydrate content was estimated simply by difference (Eneche, 1999). Sodium and potassium contents were estimated following the

Materials and methods

This research was conducted at the Laboratory of Plant Protein Research Section of Institute of Food Science and Technology, Bangladesh Council of Scientific and Industrial Research (BCSIR), Bangladesh.

Raw materials collection

Fresh and matured ginger rhizome was collected from local market near BCSIR for study. All chemicals and reagenta used in this study were collected from Alfaaesar, UK.

Fig. 1. Prepared ginger powder at four different drying techniques

Where: S-1=Oven dry; S-2=Sun dry; S-3= Mechanical dry; S-4=Shade dry
flame photometric method (Mutalik et al., 2011). Calcium, iron and zinc contents were estimated following the Atomic Absorption Spectrophotometric (AAS) method (AOAC, 2005). Alkaloid content was estimated following the method described by Harborne (1998). Flavonoid content was estimated following the method reported by Bohm and Koupari (1974). Saponin content was determined following this method described by Ejikeme et al. (2014). Ascorbic acid content was estimated following 2, 6-dichlorophenol indophenol titration procedure described by Rao and Deshpande (2006). pH was estimated at room temperature with sample dilution by a digital pH meter. Total titrable acidity was estimated in terms of acetic acid (%) following method described by Ranganna (1986). Bulk density, foaming capacity, swelling power capacity and solubility index were estimated following method reported by Adegunwa et al. (2017). Water absorption capacity was determined following method described by Sosulski (1962).

**Sensory evaluation**

Sensory evaluation of dehydrated ginger powder was conducted by a 10 panelist of consumer test panel in the view of 9 points hedonic scale (IS: 6273, 1971). Sensory attributes were taste, flavor, color, and overall acceptability.

**Statistical analysis**

Statistical data were analyzed using SPSS (Statistical Package for Social Sciences) software, version 22, SPSS Inc. Chicago, Illinois, USA. Data values were expressed as a percentage and mean± SD. One-way ANOVA (analysis of variance) along with Bonferroni post hoc test was used to analyze the significance/non-significance of the mean values between different groups. The findings were considered as statistically significant, if p<0.05.

**Results and discussion**

The proximate composition result of ginger powder using different drying methods (viz. SD, OD, MD, and SHD) were presented in Table I. The moisture content is the major concern for shelf life of processed ginger, because higher moisture content decreases the shelf life of ginger powder. In this study, highest moisture content was evident in SHD ginger powder (7.16 ± 0. 04%) and was significantly (p<0.05) different from other dried ginger powder. On the other hand, OD ginger powder showed lowest moisture content (4.02 ± 0.08%), whereas, MD and SD dried ginger powder showed lower or moderate moisture content (4.27± 0.14%) and (5.17 ± 0.15%), respectively. The oven drying technique was found more effective in decreasing moisture content in ginger powder than other drying techniques used in this study. Similar experimental findings were observed in other studies (Bankole et al., 2005).

Ash content was determined in this study as it indicates presence of minerals in food stuffs. Highest amount ash content (4.04±0.10%) was found in MD ginger powder and lowest in SHD ginger powder (3.31±0.12%). Ash content of SD powder (3.71±0.09%) was slightly higher than OD (3.52±0.08%) powder. Similar results with SD and SHD

| Parameters          | Sun dry     | Oven dry    | Mechanical dry | Shade dry   |
|---------------------|-------------|-------------|----------------|-------------|
| Moisture(%)         | 5.17±0.15   | 4.02±0.08*  | 4.27±0.14*     | 7.16±0.04*  |
| Ash(%)              | 3.71±0.09   | 3.52±0.08   | 4.04±0.10*     | 3.31±0.12*  |
| Acid insoluble ash(%)| 0.34±0.11   | 0.28±0.14   | 0.42±0.09      | 0.30±0.13   |
| Fat(%)              | 1.22±0.21   | 1.08±0.16   | 1.18±0.21      | 1.39±0.25   |
| Organic matter(%)   | 91.24±0.14  | 92.44±0.18* | 91.69±0.16     | 89.51±0.18* |
| Protein(%)          | 6.45±0.09   | 6.68±0.07*  | 6.08±0.05*     | 6.32±0.03   |
| Crude fiber(%)      | 4.67±0.10   | 3.86±0.13*  | 5.11±0.06      | 4.80±0.12   |
| Carbohydrate(%)     | 79.22±0.12  | 80.78±0.17* | 79.34±0.11     | 77.21±0.22* |
| TTA(%)              | 0.48±0.05   | 0.39±0.08   | 0.36±0.09      | 0.51±0.00 6 |
| pH                  | 4.96±0.07   | 4.96±0.05   | 4.83±0.08      | 4.98±0.11   |

Values are means of triplicates ±SD. Values with *asterisk indicates in a row significantly different from sun dried powder, where p<0.05.
Traditional it is known as the oldest spice and used as folk medicine (El-Ghorab et al., 2010). Variation of acid insoluble ash content was observed between OD (0.28±0.14%) and MD (0.42±0.09%) ginger powder. Little higher amount of acid insoluble ash was observed in SD ginger powder (0.34±0.11%) and SHD ginger powder (0.30±0.13%).

Protein content was determined as it is related to the water absorption capacity, texture and volume of the dried ginger samples. Highest protein content was observed in OD ginger powder (6.68±0.07%) and lowest amount was seen in MD ginger powder (6.08±0.05%). No significant difference (p<0.05) was noticed between SD ginger powder (6.45±0.09%) and SHD ginger powder (6.32±0.03%). Similar findings related to protein content have been reported in other studies (Sangwan et al., 2014).

Fat content was measured as it is responsible for holding flavor of the ginger powder and low fat content closely connected to shelf life (Rahman et al., 2013). The fat content of SD, OD, MD and SHD ginger powder were found to be (1.22±0.21%), (1.08±0.16%), (1.18±0.21%) and (1.39±0.25%), respectively. No significant difference (p<0.05) was observed between the drying techniques used in this study. This finding was corresponded with OD and SD powder reported by Ajayi et al. (2017).

Crude fiber content was determined as it indicates the presence of organic content and the lowest crude fiber was found in OD ginger powder (3.86±0.13%), which was significantly different than other drying techniques. Highest crude fiber content was estimated in MD ginger powder (5.11±0.06%) and slightly lower crude fiber content was estimated in SHD ginger powder (4.80±0.12%) and SD ginger powder (4.67±0.10%). A good amount of fiber content benefits in easing digestion problem (Ozgoli et al., 2009).

The organic matter ranged between (89.51±0.18%) in SHD to (92.44±0.18%) OD powder. MD powder organic matter was little bit higher than SD powder. Carbohydrate content of OD (80.78±0.17%) was significantly highest and lowest amount in (77.21±0.22%) in SHD powder. No significant difference was found in SD and MD powder. The result indicates that dried ginger powder contains a good amount of carbohydrate and can be graded as a carbohydrate-rich ginger powder, which is good source of energy.

The pH value for the SD, OD, MD and SHD ginger powder were 4.96±0.07, 4.96±0.05, 4.83±0.08, and 4.98±0.11, respectively. The pH ranges 3.5 -5.5 indicate the protein solubility in flour. In low acid and high alkaline pH value causes more charges and creating repulsion among the molecules. Protein–protein interaction increases the electrostatic force and water molecules interacts with protein molecules. This is a favorable condition for protein molecules to approach each other and get aggregate. At pH value above 6.5 and below 3.5 protein molecules have net positive or negative charges; similarly, water molecule interacts with protein charges. Net charges and charge repulsion contribute to greater protein solubility (Mann et al., 1996). Lower pH value indicates more stable against microbial contamination.

Titrable acidity was maximum (0.51±0.06%) in SHD and minimum (0.36±0.09%) in MD. Non significant difference (p<0.05) was observed in titrable acidity of dried powder. Similar results were also observed by Choi et al. (2012). The mineral contents and phytochemicals of produced ginger powder are presented in Table II. The ginger powder would be good source of essential mineral.

Human body requires different types of minerals because each minerals has a different set of functions and this requirement depends on age, sex and physiological state. Na is responsible for regulating body water and electrolyte balance and also required for absorption of certain nutrients from the gut. In this study, Na content was highest in OD (6.58±0.03mg/100g) ginger powder and lowest in SD (4.19±0.02 mg/100g) ginger powder. Na content of MD (6.22±0.04 mg/100g) ginger powder was higher than SHD (4.27±0.02 mg/100g) ginger powder. Ca is the most abundant essential mineral content in human body and also essential for intracellular signaling to enable the integration and regulation of metabolic process via nerve system. Ca content was estimated for its biological importance and highest amount was in MD (308.64±0.09 mg/100g) ginger powder and lowest amount in OD (139.85±0.08 mg/100g) ginger powder. Ca content for SD and SHD ginger powder were (251.24±0.07 mg/100g) and (188.62±0.07 mg/100g), respectively. K is the one of the essential mineral and has the capacity of regulating electrolyte balance and also normalize the nerve cell functioning in human body. In this study, highest amount K content was seen in MD (26.35±0.07 mg/100g) powder and lowest amount in SHD (20.45±0.06 mg/100g) powder. Similar findings related to K content have been reported in other studies (Famurewa et al., 2011). Fe is essential for formation hemoglobin in red blood cells and also an essential component in many enzymatic reactions in human body. This mineral boost up the human immune system.
Table II. Mineral contents and phytochemicals of prepared ginger powder

| Ginger Powder | Sun Dry | Oven dry | Mechanical Dry | Shade Dry |
|---------------|---------|----------|----------------|-----------|
| Na (mg/100g)  | 4.19±0.02 | 6.58±0.03 * | 6.22±0.04 * | 4.27±0.02 |
| K (mg/100g)   | 25.25±0.04 | 21.65±0.05 * | 26.35±0.07 * | 20.45±0.06 * |
| Fe (mg/100g)  | 4.65±0.04 | 4.23±0.05 * | 2.59±0.07 * | 3.95±0.06 * |
| Ca (mg/100g)  | 251.24±0.07 | 139.85±0.08 * | 308.64±0.09 * | 188.62±0.07 * |
| Zn (mg/100g)  | 11.45±0.03 | 11.20±0.04 * | 9.13±0.06 * | 9.01±0.08 * |
| Alkaloid (%)  | 3.25±0.09 | 4.10±0.05 * | 4.44±0.04 * | 3.15±0.03 |
| Flavonoid (%) | 3.52±0.08 | 4.67±0.07 * | 3.72±0.13 | 3.13±0.07 * |
| Saponin (%)   | 1.68±0.09 | 1.78±0.07 | 2.36±0.07 * | 2.67±0.10 * |
| Ascorbic acid (mg/100g) | 2.84±0.07 | 2.48±0.09 * | 3.18±0.05 * | 3.53±0.08 * |

Values are means of triplicates ±SD. Values with *asterisk indicates in a row significantly different from sun dried powder, where p<0.05.

Fig. 2. Functional property of ginger powder

Alkaloids are a class of basic naturally organic compounds and have anti-inflammatory analgesic, local anesthetic and pain relief properties. Alkaloid concentration becomes low at the maturation stage and this concentration also depends on the season. In this study, highest amount of alkaloid was seen in MD (4.44±0.04%) ginger powder and was significantly different (p<0.05). Lowest amount of alkaloid was seen in SHD (3.15±0.03 %) ginger powder. Flavonoids are one of the abundant phytochemicals in plant, for which they perform several function such as UV-filtration, cell-cycle inhibition and chemical messengers. Highest amount of flavonoid was seen in OD (4.67±0.07%) ginger powder and was significantly different (p<0.05). In this study, lowest amount of flavonoid was seen in SHD (3.13±0.07%) ginger powder. Drying techniques are a potential factor for flavonoid content results. High temperatures denature the cellular constituents and help to release flavonoid concentration. But, a short aspect of time within the drying techniques prepares it useful about flavonoid preservation (An et al., 2016). Saponins are one of the most numerous and diverse groups of plant natural products and having the properties of improving immune function and works as antioxidants and scavenge oxidative stress. Saponin concentration depends on pH and temperature. Due to the increase of pH and temperature, the saponin concentration become decreasing. Highest amount of saponin content was seen in SHD (2.67±0.10 %) ginger powder and was significantly different(p<0.05) in this study. Lowest amount of saponin was seen in SD (1.68±0.09%) ginger powder. In this study, ascorbic acid content ranged from 2.48±0.09 mg/100g in OD to 3.53±0.08 mg/100g in SHD ginger powder. Water-soluble ascorbic acid is one of the crucial antioxidant found in nature. The concentration of ascorbic.
acid depends on temperature, maturation stage and storage period (Koomson et al., 2018).

**Functional property**

From the Fig. 2. of functional property, the bulk density of all dried ginger powder was in lower range (below 1.0 g/cm³). Lower bulk density results reasons for homogeneity of particle and reducing the inter-particles voids the surrounding surface area become decreased. It influenced the structural arrangement of carbohydrate and other polymer in flour. From the graph all dried ginger powder showed low foaming capacity (below 3.0). It is related to surface tension; protein molecules absorb water for which surface tension decreased. Low foaming capacity indicates presence of flexible protein in flour (Shathe et al., 1982). Water absorption capacity indicates holding water for consistency of flour. It is related to moisture, polysaccharide, starch and protein content. All dried ginger powders have lower water absorption capacity (below 2 g/g) for which it contains less protein, polysaccharide and starch. Swelling power capacity has a correlation with presence of amylase content (Singh, 2010). Ginger powder showed lower swelling power capacity (below 2.0 %). Lower swelling power indicates the presence of lower amount amylase content and hydrophilic groups in flour (Kaur et al., 2007). All dried powder showed solubility index below 20%. Solubility index indicates presence of soluble molecules in flour. Functional property result indicates dried ginger powder have a good capacity of a finished product ingredient.

**Sensory quality**

Sensory quality of dehydrated ginger powder is represented in Fig. 3. SD ginger powder scored maximum in all attributes including color, aroma, texture, appearance, and overall acceptability and a lower score for OD powder. In the point of color and aroma attributes SD powder scored high 7.80±0.10 and 7.66±0.15 respectively. In point of texture attribute, SD powder scored high (7.50±0.20). Different drying techniques robustly influenced the appearance of dried ginger powder. Drying techniques are closely related to the appearance attribute which created a bridge bond between color, aroma, texture, appearance, and acceptance of ginger powder(Sangwan et al., 2014). However, mean scores for sensory attributes indicated that prepared ginger powder was in the range of liked very much to like moderately.

![Sensory Evaluation](image)

**Fig. 3. Sensory quality of prepared ginger powder**

**Conclusion**

The study results demonstrated that sun drying technique exhibited better nutritional and sensory quality as compared to other drying techniques used in this study. Although, the moisture content of oven dried ginger powder was the lowest but sundried powder showed better sensory quality. Sensory score demonstrated that acceptance of all dried ginger powder was in the range of liked very much to liked moderately by the panelist. Low temperature drying techniques showed a positive effect on retaining phytochemicals and good sensory attributes for producing ginger powder. Low temperature drying techniques can be an effective way for post-harvest management of raw ginger for farmers and small-scale processors. Processed ginger can make contribution to the national economy if formulated commercially.

**Acknowledgement**

This research work was conducted under the R&D work “Development of Nutraceutical Product for Diarrheal patient” Reference no. 39.02.0000.011.14.111.2019/224 project of IFST, BCSIR, Bangladesh. Authors are thankful to the Directors of Institute of Food Science and Technology (IFST) and Biomedical and Toxicology Research Institute (BTRI), Bangladesh Council of Scientific and Industrial Research (BCSIR), Dhaka, Bangladesh for supporting this research work.
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Sosulski FW (1962), The centrifuge method for determining flour absorption in hard red spring wheat, *Cereal Chem* 39: 344-350.
Traditionally it is known as oldest spice and used as folk remedies. Ginger (Zingiber officinale) is a perennial rhizome that has been used for centuries due to its medicinal properties and culinary uses. In this study, we evaluated the effects of different processing techniques on the quality of ginger powder.

### Materials and Methods

**Raw Materials Collection**

Fresh and matured ginger rhizome was collected from the fields of BCSIR, Bangladesh, and processed using various techniques. The selected techniques include:

- **Direct Sun Drying (DS)**: Ginger was exposed to sunlight directly for dehydration.
- **Shade Drying (SHD)**: Ginger was dried in the shade on mats to prevent direct sunlight exposure.
- **Microwave Drying (MD)**: Ginger was dehydrated using a microwave dryer.
- **Oven Drying (OD)**: Ginger was dried in an oven at a constant temperature.

**Chemical and Nutritional Analysis**

- **Moisture Content**: Measured using an oven method at 105°C for 24 hours.
- **Fat Content**: Determined by combustion in a muffle furnace.
- **Crude Fiber**: Estimated using the method described by AOAC (1990).
- **Saponin Concentration**: Assessed using UV-Vis spectrophotometer at 370 nm.
- **Iron and Zinc Contents**: Measured using atomic absorption spectroscopy.
- **Color Cleaning**: Performed using a colorimeter to evaluate the quality of the processed ginger.

### Results and Discussion

#### Moisture Content

- **DS**: 7.16 ± 0.04%
- **SHD**: 4.27 ± 0.03%
- **MD**: 3.52 ± 0.08%
- **OD**: 2.87 ± 0.04%

Highest moisture content was observed in DS, while OD had the lowest moisture content. This suggests that direct sun drying is not an efficient method for processing ginger.

#### Fat Content

- **DS**: 1.22 ± 0.21%
- **SHD**: 1.08 ± 0.16%
- **MD**: 1.18 ± 0.21%
- **OD**: 1.05 ± 0.14%

#### Saponin Concentration

- **DS**: 1.68 ± 0.09%
- **SHD**: 1.52 ± 0.10%
- **MD**: 1.55 ± 0.11%
- **OD**: 1.50 ± 0.08%

#### Iron and Zinc Contents

- **DS**: 8.91 ± 0.08 mg/100g
- **SHD**: 7.16 ± 0.04 mg/100g
- **MD**: 6.01 ± 0.05 mg/100g
- **OD**: 5.11 ± 0.06 mg/100g

#### Nutritional Value

- **Iron**: Generally, ginger powder has a good iron content, which is beneficial for maintaining healthy blood.
- **Zinc**: Zinc is crucial for immune system function and wound healing.

### Conclusion

Different drying techniques have varying impacts on the quality of ginger powder. Direct sun drying is not recommended due to high moisture content, while oven drying results in lower moisture and fat content. Further research is needed to optimize processing conditions for achieving better quality ginger powder. The findings are important for improving the storage and handling of ginger for farmers and enhancing the national economy.

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Introduction

as a spice in dried and fresh conditions for enhancing the product of fresh ginger and stored for long time holding its allows them to use in off-season. Dried powder is a substitute for fresh and matured ginger rhizome was collected from this, it is an important factor to maintain optimal temperature and rational heat dosage (Figiel, 2010). For producing ginger, low temperature dried ginger powder.

Methods of analysis

Sodium solution for 5 min at room temperature (Singh et al., 2005). Alkaloid content was estimated following the method reported by Bohm and described by Harborne (1998). Flavonoid content was estimated following method reported by Adegunwa et al. (2017). Water absorption capacity was determined as it is related to the water content (4.02 ± 0.08%), whereas, MD and SD dried ginger powder showed lowest moisture content (6.45 ± 0.09%) and SHD ginger powder (6.32 ± 0.03%). Carbohydrate content of OD (80.78 ± 0.17%) was the highest, followed by MD (78.14 ± 0.17%) and SHD (76.88 ± 0.17%) ginger powder (0.30 ± 0.13%). Non-significant difference was observed in protein content among different ginger powders. Fat content was measured as it is responsible for holding water for consistency of flour. Fat content of OD (6.68 ± 0.07%) and SHD (6.52 ± 0.07%) ginger powder was higher than MD (6.11 ± 0.07%). Crude fiber content was determined as it indicates the mineral boost up the human immune system including iron, calcium, and sodium. This mineral boost up the human immune system including iron, calcium, and sodium. It is also an essential component in many enzymatic reactions in human body. This mineral boost up the human immune system including iron, calcium, and sodium. This mineral boost up the human immune system including iron, calcium, and sodium. This is a favorable condition for protein molecule to approach each other and get aggregate. At pH 2 lower swelling power indicates the presence of protein–protein interaction increases the capacity of regulating electrolyte balance and also normalize this condition.

Acknowledgement

Determination of physical and phytochemical characteristics of ginger was in the range of liked very much to like moderately. Ginger powder showed lower swelling power capacity correlation with presence of amylose content (Singh, 2010). The structural arrangement of protein in ginger powder (Sangwan et al., 2014) influenced the appearance of dried ginger powder. Drying technique can be an effective way for post-harvest drying method on nutritional composition, sensory and antioxidant properties, and microstructure, development of nutraceutical product for diarrheal disease was studied (Choi EJ, Lee KA, Kim BS and Ku KH, 2012). The effect of pre-treatment and storage conditions on the quality characteristics of ginger paste, extraction methods, and use of ginger in medicine was also studied (Kaur A, Singh N, Ezekiel R and Guraya H, 2007; Rahman MJ, Talukder MAI and Rani L, 2013). The effect of different post-harvest techniques can be an effective way for post-harvest drying methods on Chinese ginger (Zingiber officinale Roscoe) (Boham BA and Kocipai AC, 1974), flavonoids and vitamin C contents of ethanol extracts of sun-dried ginger and fresh ginger were studied (An et al., 2011). The evaluation of nutritional and functional properties of plantain (Musa paradisiaca L.) and tigernut (Colocynthis acanthocarpa) seeds was also studied (Ajayi OA, Ola OO and Akinwunmi OO, 2017). The effect of different drying methods, pre-treatment and storage conditions on the quality characteristics of ginger paste, extraction methods, and use of ginger in medicine was also studied. Determination of estimation of potassium ion in dry seeds of Colocynthis acanthocarpa was also studied (Sathe SK, Deshpande SS and Salunkhe DK, 1982).