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# Ragi: A Powerhouse of Nutrients

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## *Abstract*

*Finger millet (Ragi, Eleusine coracana), is the principal food grain of the rural population in India, especially in South India. It is very nutritious with respect to minerals, dietary fiber and essential amino acids. Amongst cereals, Ragi provides highest level of calcium including antioxidants and phytochemicals. The total dietary fiber of finger millet grain is relatively higher than that of most of other cereal grains, which helps to control blood glucose levels in diabetic patients. It is usually converted into flour and a variety of preparations. Several methods of processing of ragi have been developed to make the final product more attractive in flavour, appearance, taste, and consistency.*

***Keywords:*** *Finger millet, ragi, nutrients, vitamin, bioavailability*

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## INTRODUCTION

Finger millet (Ragi, *Eleusine coracana*) is an important staple food in the Eastern and Central Africa as well as some parts of India [1]. According to the US National Research Council (1996) [2], finger millet is more nutritious than most cereal grains with respect to minerals, dietary fiber and essential amino acids. Finger millet also contains various phenolic compounds exerting antioxidant properties [3]. Finger millet (*Ragi*, *Eleusine coracana*) was traditionally used as porridge made from boiled groats; foods made from the flour are mainly mixed with cereals, and it is also used for malting in beer substitutes. It is rich in protein, iron, calcium, phosphorus, fiber and vitamin content. The fiber and calcium content is higher than all cereals and iodine content is said to be highest among all the food grains [4, 5]. With the changes in scenario of utilization of processed products and awareness of the consumers about the health benefits, finger millet has gained importance because of its functional components, such as slowly digestible starch and resistant starch [6].

*Ragi* has best quality protein, desired essential amino acids, vitamin A, vitamin B complex and phosphorus [7]. Thus, *ragi* is a good source of diet for growing children, expecting women, old age people and patients. *Ragi* provides highest level of calcium including antioxidants and phytochemicals, which makes it easily digestible. Hence, it helps to control blood glucose levels in diabetic patients. The bulkiness of the fibers and the slow digestion rate makes us feel fuller on, fewer calories and therefore may prevent us from consuming excess calories. Ragi is considered to be an ideal food for diabetic individuals due to its low sugar content and slow release of glucose/sugar in the body [8, 9]. The powerful influence of diet on health and wellbeing, and increasing scientific evidence confirms that specific components in diet may tend off certain chronic diseases such as cardiovascular diseases, various cancers and neurological disorders [10]. It has revitalized the interests not only in consumer, but also among researchers and food product processors to develop formulated products, which are "natural, functional and nutritional" as well.

Finger millet is so called because the ear (head of grain) consists of five spikes, which radiate, sometimes in a curving manner, from a central point, rather as fingers attached to the palm of the hand [11]. Finger millet is an important source of food in Central Africa and India. Finger millet (*Eleusine coracana* [L.] Gaertn. syn.: *Cynosurus coracanus* L., *E. Stricta*

Roxb.) is also known by names such as: African millet, bird's food, coracana, *ragi* in India, *dagusha* in Ethiopia and Eritrea, *wimbi* in Swahili in East Africa, *Bulo* in Uganda, and *tamba* and *pwana* in Nigeria. The grains of finger millet are very small in size varying in diameter from 1 to 2 mm. They vary in colour from deep brown to shades ranging from red to almost black. There is also a race of ragi which gives white seeds [11].

The nutritive potential of millets in terms of carbohydrate, protein, and energy values can be compared to that of popular cereals such as rice, wheat, or barley. Millets contain the highest percentage of healthy dietary fibers among the cereals [4, 12] and a higher mineral content than rice or wheat.

## NUTRITIONAL VALUE

Millets are also a gluten-free food, commonly used like porridge. Nutritional value of the seeds is as follows: 100 g of edible part of seed (at 12% moisture) contains 7.7 g protein, 1.5 g fat, 2.6 g ash, 3.6 g crude fiber, 72.6 g carbohydrates, 350 mg Ca, 3.9 mg Fe, 0.42 mg thiamine, 0.19 mg riboflavin, and 1.1 mg niacin and 1406 KJ of energy value [13]. The husk forms 5.6% of the weight of the grain [11]. The grain is higher in protein, fat, and minerals (calcium, iron, and phosphorous), relative to rice, corn, and sorghum [4, 14, 15].

Rao [16] reported PER of 1.40%, protein digestibility of 76% and net protein utilization of 35 for a diet containing 100% finger millet. *In vitro* protein digestibility ranged from 55.4% to 88.1% in 32 varieties of finger millet [17]. Antony and Chandra [18, 19] reported *in vitro* protein digestibility in the range of 50–65%. Mittal [20] reported *in-vitro* protein digestibility (IVPD) of native finger millet flour as 62.94%.

### Carbohydrate

Total carbohydrate content of finger millet has been reported to be in the range of 72–79.5% [4, 21–23]. Pore and Magar [21] reported reducing sugar in the range of 1.2–1.8% whereas Nirmala *et al.* [24] reported value of 1.5% reducing sugar and 0.03% nonreducing sugar in finger millet. Ramulu and Rao [25] reported total dietary fiber (TDF), insoluble dietary fiber (IDF), and soluble dietary fiber (SDF) content in finger millet to be 12.0%, 11.0%, and 2.0%, respectively. Kamath and Belavady [26] found 18.6% dietary fiber and 3.6% crude fiber in finger millet. Joshi and Katoch [22] reported 3.7% crude fiber in finger millet.

In ragi, the carbohydrates include starch as the main constituent being 59.4–70.2% [13, 20, 21, 24, 27]. Finger millet starch granules exhibit polygonal rhombic shape [28]. About 80–85 % of the finger millet starch is amylopectin and remaining 15–20% is amylase [27, 28]. Bhatt *et al*. [23] reported that nonstarch polysaccharide account for 20–30% of the total carbohydrates in finger millets.

Mohan *et al.* [29] reported that the degree of crystallinity of *ragi* starch granules seems to be significantly higher than rice starch granules and this was also reflected by high energy required to gelatinize ragi starch as compared to rice starch. They reported that the swelling power of ragi was maximum at 90ºC gelatinization temperature. On the other hand, Mangala and coworkers [30] reported that ragi starch showed 100% gelatinization at a temperature of 71.7ºC.

### Protein

The protein content of finger millet grain varies from 4.9% to 11.3% [31]. White finger millet grain varieties were found to contain more protein than brown varieties [16, 32]. The mean protein content of 7.3% is similar to that of rice, i.e., 7.9% [33] and either lower or similar to that of other millets—sorghum and wheat [33, 34]. The prolamins constitute the major protein fraction in finger millet grain, followed by glutelins [35]. The proteins in finger millet have been found to be nutritionally better balanced than proteins in other millets [36]. Finger millet contains 44.7% essential amino acids [37] of the total amino acids, which is higher than the 33.9% essential amino acids in FAO reference protein [38]. Eleusinin, the main protein fraction of finger millet grain, has good amounts of tryptophan, cystine, methionine and total aromatic acids, which are important in human health and growth and deficient in most cereal grains [2]. Finger millet is particularly high in methionine, ranging around 5% of protein [2, 39]. However, as with other cereals, lysine is limiting in finger millet grain, but among the millets pearl and finger millets usually have most lysine [31].

Tryptophan is usually the second most deficient amino acid in cereals. However, it is not deficient in finger millet. Threonine too was not deficient, in contrast to rice, wheat and sorghum [40]. Among millets, finger millet is relatively better balanced in essential amino acids because it contains more lysine, threonine and valine [36]. Antony *et al*. [13] reported that finger millet had sulphur containing amino acids equal to that of milk.

**Lipids**
The total lipid content of finger millet grain is approximated to be 5.2%, with palmitic, oleic and linoleic acids being the main constituents [31]. Fat content in the form of free lipids is 1.3% [34]. Finger millet grain has a low fat content probably because it has a relatively small germ [35]. The low fat content of finger millet may be significant in that the grain may have superior storage properties due to a low tendency to become rancid.

**Minerals**
The total ash content is higher in finger millet than in commonly consumed cereal grains. Calcium deficiency leading to bone and teeth disorder, iron deficiency leading to anemia can be overcome by introducing finger millet in the daily diet. The ash content has been found to be nearly 1.7–4.13% [41] in finger millet. Most of the studies have shown it in the range of 2.1–2.7% [23, 42–45]. Finger millet is a rich source of minerals, particularly calcium, which apparently can be 5–30 times more than in most cereals [2]. Finger millet also has high levels of potassium, iron, magnesium, copper, sodium and phosphorus [34]. The pericarp, aleurone layer, and germ are rich sources of minerals [35]. However, the bioavailability of some of the minerals (e.g. phosphorus and divalent metal ions) may decrease due to their interaction with anti-nutritional factors, mainly phytic acid, oxalic acid and condensed tannins, which are present in finger millet grain [35, 31].

Finger millet is the richest source of calcium and iron [46]. Finger millet is rich in calcium. Calcium content of 36 genotypes of finger millet ranged from 162 mg% to 487 mg% with mean value of 320.8 mg% [47]. The average calcium content (329 mg%) in white varieties was considerably higher than the brown (296 mg%) varieties [48]. Bhatt *et al.* [23] reported the calcium content of finger millet as 344 mg%.

The iron content of finger millet ranged from 3.3 mg% to 14.8 mg% [49]. Singh and Srivastava [50] reported the iron content of 16 finger millet varieties ranged from 3.61 mg/100 g to 5.42 mg per 100 g with a mean value of 4.40 mg/100 g. Singh and Srivastava [50] observed that the zinc content of the 16 varieties of finger millet ranged from 0.92 mg% to 2.55 mg% with a mean value of 1.34 mg%. The phosphorous content ranged from 130 mg% to 295 mg% with a mean value of 180.43 mg% [50].

**Vitamins**
Millets in general are rich sources of vitamin B but available data are very meager on vitamin content of millets. Gopalan *et al.* [51] reported a value of 45 μg carotene per 100 g of finger millet while Bhaskaracharya [52] reported that finger millet is very poor source of β-carotene (0–1 μg/100 g). Vitamin A content of finger millet has been reported to be 6 retinol equivalents [53].

Finger millet contains both water-soluble and fat soluble vitamins—thiamine, riboflavin, niacin and apparently vitamin C plus the tocopherols (vitamin E) [34, 35]. Vitamin C is absent in the dried grain [35]. The water-soluble B-vitamins are concentrated in the aleuronic layer and germ, while the liposoluble vitamins are mainly located in the germ [35].

**Fiber**
The physiological actions promoted by fiber addition in foods include the maintenance of gastrointestinal health, reduction of intestine transit time, protection against colon cancer, lowering of total and low-density lipoprotein cholesterol in the blood serum, reduction of postprandial blood glucose levels, increase of calcium bioavailability and reinforcement of the immunological system [54]. The recommended daily intake for total fiber for

adults has been set at 38 g for men and 25 g for women [55].

The total dietary fiber (~ 22%) of finger millet grain is relatively higher than that of most of the other cereal grains (i.e., 12.6%, 4.5%, 13.4%, and 12.8% for wheat, rice, maize and sorghum, respectively) [33]. As in other cereal grains the fiber components of finger millet grain are located in the cell walls (mainly in the all walls of the pericarp and endosperm) [35]. Kamath and Belavady [26] reported that dietary fiber made up 18.6% of the finger millet grain and comprised of 6.1% noncellulosic polysaccharides (1.5% water soluble and 4.7% water insoluble), 4.7 % cellulose and 7.9 % lignin. The high fiber content slows the rate of digestion, enabling consumers to work for long hours on a single meal of this millet [4, 14, 15].

## ANTIOXIDANT ACTIVITY

Finger millet grain contains various phenolic compounds including tannins [17, 31, 35]. These phenolic compounds have been reported to exhibit antioxidant activity [15, 56, 57]. There is a growing interest in plant phenolic compounds because of their antioxidant and free radical-scavenging activity, which have potential health-beneficial effects [58, 59]. Phenolic antioxidants are potent inhibitors of biological oxidation and because of this; they may reduce the risk of health conditions such as cardiovascular disease and cancer and, may help mitigate the adverse effects related to ageing [58–61].

## NUTRITIONAL INHIBITORS AND TOXIC FACTORS

The bioavailability of finger millet proteins may be adversely affected by antinutritional factors, which may be present in the finger millet grain, mainly trypsin inhibitors and phenolic compounds, particularly the condensed tannins [31, 35].

Finger millet also contains phytate (0.48%), polyphenols, tannins (0.61%), trypsin inhibitory factors, and dietary fiber, which were once considered as “antinutrients” due to their metal chelating and enzyme inhibition activities [62] but nowadays they are termed as “Nutraceuticals”. Tannins bind to both exogenous and endogenous proteins including enzymes of the digestive tract affecting utilization of proteins. Soaking, roasting, boiling, germination and fermentation have been found to reduce tannin content [63, 64]. Malting decreased the tannin content by 54% in brown finger millet.

Phytate content in finger millet as observed by various authors has been found to be in range of 0.679–0.693 g/100 mg [19]. Agte and Joshi [65] reported that for cereal-based vegetarian meals, processing such as soaking cereal flour prior to heating can activate phytases and therefore favor zinc availability. Malting of the grain significantly reduced the phytin phosphorus content of finger millet [44]. Rao [16] reported that malting decreased the phytin phosphorus content by 58–65% in brown and white finger millet varieties, respectively. Mamiro *et al*. [66] found that there was marked reduction in phytic acid content in finger millet during processing. Phytic acid decreased by 49.2% and 66.5% after germination and fermentation, respectively. Phytic acid decreased in finger millet by 84.7% when combinations of processing methods were used. The partial retention of phytates is beneficial for their contribution to health benefits such as antidiabetic, antioxidant and anticancer effects, which have been recently recognized [62, 67].

## PROCESSING OF FINGER MILLET

Methods of food processing have been developed over the centuries and are adopted to make the final product more attractive in flavour, appearance, taste, consistency etc.

### Grinding/Milling

Finger millets containing large portion of husk and bran require dehusking and debranning prior to consumption [4]. In the process of milling of food grains, the main objective is to remove the coarse fibrous bran or the seed coat. However, in all these processes the nutrient rich parts of the grain, namely the germ and the aleurone layers, are also displaced resulting in a product poorer in nutrient content [68]. Millets were earlier decorticated at household level by hand pounding, but are currently milled in rice milling machinery. The millets are mostly powdered in plate mills and the whole meal is used for traditional food preparations [69].

  

Dry, moistened or wet grain is normally pounded with wooden or stone mortar. Moistening the grain by adding about 10% water facilitates removal of fibrous husk [45]. Hadimani and Malleshi [70, 71] reported the use of moist conditioning, grinding and sieving to obtain finger millet flour. In wet milling, millet is soaked in water overnight (and sometimes longer) and then ground to paste by hand often between two stones [45]. Milled grains hydrate quickly and cook to soft texture in a short time. During milling, some starch granules (usually 5–10%) are physically damaged by grinding action of roller mills.

The seed coat of the millet, which forms about 15% of the kernel, is a rich source of calcium, dietary fiber and polyphenols [72]. Generally, the millet is pulverized and the whole meal is utilized for preparation of food products. Even though, the seed coat of the millet is edible, it imparts chewy texture and dark colour to the food products and hence, its separation is desired to prepare the product of enhanced consumer. Hence, preparation of millet flour almost free from the seed coat by incipient moist conditioning, pulverizing and sieving the native as well as the malted millet and also by decortications of the hydrothermally processed millet is being practiced [73].

In a study carried out in 2008 by Smitha and coworkers [74], finger millet (*Eleusine coracana*) was milled in attrition (iron plates), abrasion (carborundum coated plates), comminuting (pin and hammer) and compression-cum-shearing (roller) mills and the physicochemical characteristics of the flours (whole meals) were studied. The particle size of the flours from roller, emery and plate mills were finer than the pin and hammer mill flours and their damaged starch (DS) content was 22.8%, 10.6%, 9.4%, 7.2%, and 5.0%, respectively.

Intact starch granules are relatively resistant to α- and β-amylases, whereas damaged granules are susceptible to enzyme attack. With increased starch damage, the water binding capacity of flour increases but excessive starch damage causes a decrease in water binding ability [68].

**Roasting**

Traditional roasting of grains is used primarily to enhance flavor, but other benefits include reduction of antinutritional factors [75–77] and extension of storage life [78]. Roasting and grinding processes render the grain digestible, without the loss of nutritious components [79]. The puffing and roasting are almost similar processes, but the volume expansion in puffing is higher [80]. Roasting of cereals, pulses and oilseeds is a simpler and more commonly used household and village level technology, which is reported to remove most antinutritional or toxic effects such as trypsin inhibitor, hemagglutinin, goitrogenic agents, cyanogenic glycosides, alkaloids and saponins and increase storage life [78, 81].

Weaning foods prepared by roasting of barnyard and finger millet increased iron bioavailability [82]. Shukla and Srivastava [83] developed a nutritious and instant baby food from finger millet using different processing techniques, i.e., roasting and malting. Roasting was carried out in iron skillet at 125ºC for 10 min. The baby food prepared from finger millet after roasting exhibited higher content of protein, calcium and iron. In another study it was reported that roasting resulted in no significant effects on the physicochemical properties of finger millet grains [84].

Finger millet subjected to roasting at different temperatures for a different time was milled into flour and porridge was prepared. It was found that porridge viscosity decreased with increasing roasting time and temperature. Viscosity decreased by 50–60% in roasted finger millet; however, roasting did not affect the proximate composition [85].

Roasting of seeds at higher temperatures produced undesirable flavors and darkened colors due to heat-enhanced chemical reactions. Hence a roasting temperature of 125ºC for 10 min was suggested by Shukla and Srinivas [83].

**Popping**

Popping or puffing is a simple processing technique of cereals to prepare ready-to-eat products. Popped grain is crunchy, porous and a precooked product. Popping invariably improves taste and flavour. Malleshi and Desikachar [86] observed that to obtain fully expanded millets, the grain moisture content should be 19% and popping temperature of about 250ºC. It is difficult to debran popped grains hence popped grains have slightly higher fiber content. Popping of millets produces a porous product of low bulk density and pleasing texture with a distinct appealing flavour [87].

Popped grains especially of finger millet possess a pleasant aroma and acceptable taste. Popped grains besides useful as a convenient food, could be used as a component of nutritious foods in the nutrition intervention programmes [88]. Popping/puffing increases the *in vitro* nitrogen and starch digestion. Increase in starch digestibility has been attributed to high degree of starch gelatinization and release of starch granules from protein matrix, rendering them more susceptible to enzymatic digestion [89].

**Malting**

Malting of finger millet improves digestibility and bioavailability of nutrients, improves sensory and nutritional quality [44]. The main malting processes are steeping, germination and drying. During malting the cereal, grain undergoes three main types of modification: (i) mobilisation of hydrolytic enzymes; (ii) a variety of chemical changes that occur in the grain and; (iii) physical changes, which appear as softening and weakening of the grains [90]. The modification renders the constituents of the grain more readily soluble, which is significant in different respects including that it results in less viscous food products and it enables biochemical reactions to occur [91].

Malting of finger millet is a common technique in India. Malted finger millet is used as a nourishing food for infants and is considered as wholesome food for diabetics [15]. Malleshi and Desikachar [44] reported that finger millet malt has highly agreeable flavour with adequate starch hydrolyzing enzymes.

There was decrease in protein content after malting [16, 92, 93]. An increase in lysine, tryptophan, methionine and cysteine content during sprouting has been reported [37, 44]. Losses in iron, calcium and phosphorous have also been reported due to malting and germination [16, 92]. Such losses have been observed, due to removal of seed coat of finger millet grain. Ionisable iron and soluble zinc contents increased significantly after malting, in brown and white finger millet [16]. Rao [94] found that malting decreased the tannin and phytin phosphorous in brown and white finger millet, respectively. During sprouting of finger millet, growth of lactic acid bacteria, a desirable microflora has been reported. The associated changes are beneficial in the development of traditional foods [95]. The chemical composition of malted and unmalted ragi flours is given in Table 1.

Malted seeds produce finer flours with diminished starch-swelling capacity and reduced gruel viscosities. Lower viscosities allow greater flexibility in adjusting flour concentrations [84]. A significant increase in vitamin C content after malting was found which was attributed to the enzymatic hydrolysis of starch by amylases and diastases, which degrade starch and produce glucose. This increased amount of glucose becomes the precursor of vitamin C [96, 97].

In studies on utilization of malted ragi in cake, the results showed that there was decrease in pH and increase in titratable acidity as the quantity of malted ragi flour increases [98]. This change may be due to the hydrolysis of fats to produce fatty acids and production of ascorbic acid during germination process [96, 97].

***Table 1:*** *Chemical Composition of Unmalted and Malted Ragi Flour.*

| Parameter | Unmalted | Malted |
|---|---|---|
| Moisture (%) | 12.67 | 12.67 |
| Protein (%) | 7.52 | 7.60 |
| Fat (%) | 1.08 | 1.14 |
| Total carbohydrate (%) | 76.51 | 76.18 |
| Crude fiber (%) | 3.62 | 3.80 |
| Vitamin C (mg/100 g) | 2.12 | 5.89 |
| Calcium (mg/100 g) | 359.4 | 429.8 |
| Iron (mg/100 g) | 13.7 | 12.4 |
| Phosphorus (mg/100 g) | 284.3 | 305.5 |
| Ash (%) | 1.76 | 1.93 |

*Source: Desai et al. (2010) [98].*

 

## USES OF FINGER MILLET

Ragi is the principal food grain of the rural population in India, especially in the Southern region. It is usually converted into flour and a variety of preparations such as ragi *dosa* (a pancake), ragi "muddae" (porridge) etc. The grain is also malted and the flour of the malted grain is used as a nourishing food for infants and invalids. Malting releases the amylases which dextrinize the grain starch. An added advantage of malting ragi is in the production of an agreeable odour developed during the kilning of the germinated grain. Malted ragi flour is called "ragi malt" and is used in the preparation of milk beverages. A fermented drink is also prepared from the grain in some parts of the country [11]. Because of its high level of soluble fibre and good thickening properties it has got a great potential for use in preparation of ice cream [99–101].

## HEALTH BENEFITS OF FINGER MILLET

The interest in finger millet due to its health benefits namely, hypoglycemic characteristics [9] and also antimicrobial and antioxidant activities of its polyphenols have been growing [72]. Evidence has long shown that patients with diabetes tolerate finger millet better than rice and that their blood sugar levels are lower [102]. Ragi is an ideal food for the obese because its digestion is slow due to which the carbohydrates take a longer time to get absorbed. By eating preparations made from ragi, the constant desire to eat is curbed, thus reducing calorie intake. At the same time, it supplies an abundant quantity of calcium, phosphorus, iron, vitamin B1 and B2 and prevents malnutrition in spite to restricted food intake [53]. Consumption of ragi can reduce the risks of fractures and osteoporosis to a considerable extent. Tryptophan—an amino acid present in ragi—reduces excess appetite and helps to control weight gain. Fiber in ragi gives you a feeling of fullness, and the slower digestion rate of the cereal allows you to take less calories. This supports the process of weight loss. The amino acid called tryptophan present in ragi acts as an excellent natural relaxant and helps to fight anxiety, insomnia and depression. The amino acid also helps in treating migraine headaches [36]. Consumption of finger millet-based diet is helpful for people with diabetes because of the higher fiber content as compared to rice and wheat. Whole finger millet-based diet has a lower glycemic response (measure of the food's ability to elevate blood sugar—useful for diabetics) due to the presence of antinutritional factors in whole finger millet flour which are known to reduce starch digestibility and absorption [54]. Millets have hypoglycemic effect, which is attributed to high fiber content. High fiber diets containing complex carbohydrates are slowly digested and absorbed thus bring reduction in postprandial glucose [103]. In many parts of Africa ragi is a folk remedy for leprosy and liver disease [104]. The leaf juice has been given to women in childbirth, and the plant is reported to be diaphoretic, diuretic, and vermifuge [104]. The seed coat of the millet is an edible component of the kernel and is a rich source of phytochemicals, such as dietary fiber and polyphenols (0.2–3.0%) [17, 71]. It is now established that phytates, polyphenols and tannins can contribute to antioxidant activity of the millet foods, which is an important factor in health, aging and metabolic diseases [58].

## LEGAL STANDARDS OF RAGI

The Government of India has published "Agmark" specifications for various grades of ragi obtained from Karnataka, Orissa, Pondicherry and Tamil Nadu markets in India. The various Grade designations of ragi are given in Table 2.

***Table 2:*** *"Agmark" Grade Designations of ragi and maximum limit of tolerance.*

| Grade designation | Foreign matter (% by wt.) | Other food grains other than wheat (% by wt.) | Non-food grains | Damaged grain | Slightly damaged grain | Weevilled grains | Immature and shriveled grains (% by wt.) |
|---|---|---|---|---|---|---|---|
| I | 1.5 | 2.0 | 0.5 | 1.0 | 3.0 | 2.0 | 0.5 |
| II | 2.5 | 3.0 | 1.0 | 2.0 | 4.0 | 4.0 | 2.0 |
| III | 3.5 | 4.0 | 1.5 | 3.0 | 6.0 | 6.0 | 4.0 |
| IV | 4.0 | 6.0 | 2.0 | 5.0 | OVER 10.0 | 6.0 | 10.0 |

***Definitions***

*Foreign Matter:* It includes dust, stone, lumps of earth, chaff, stem or straw and any other impurity including nonedible seeds.

*Other Food Grains:* Edible food grains other than ragi.

*Damaged Grains:* Grains that are internally damaged or discolored damaged and discoloration materially affecting the quality.

*Slightly Damaged Grains:* Grains that are superficially damaged or discolored damage and discoloration not materially affecting the quality.

*Immature and Shriveled Grains:* Grains that are not properly developed.

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