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# Development of Low Cost Enhanced Nutritious Laddu from Locally Available Millets

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## Abstract

**Background:** Millets are an excellent source of many essential nutrients. However, the nutrients, bioactive compounds, and functions of cereal grains can be influenced by the food preparation techniques such as decortication / dehulling, soaking, germination/malting, milling, fermentation, etc. **Objective:** The present study was done on selected millets such as pearl millet, proso millet, foxtail millet and barnyard millet and its physical and functional properties of millets before and after sprouting. **Methods and Material:** The studied parameters were thousand kernel weight, thousand grain volume, bulk density, hydration capacity, hydration index, swelling capacity, swelling index, particle size, tapped bulk density, loose bulk density, water absorption capacity, oil absorption capacity, swelling power, dispersibility, wettability, flowability, cohesiveness, gelatinization, percentage, paste clarity and viscosity. Further studied was carried out for acceptability test. **Result:** Studied revealed that laddus prepared form the sprouted millets flours had more acceptability that than laddus made from unsprouted millets.

**Keywords:** Millets; Soaking; Sprouting; Unsprouted; Laddu; Physical and functional properties; Nutrient composition

## 1 Introduction

Millets are one of the most essential cereal grains. They are an important part of many traditional diets in various parts of the nation. Millets are consumed by more than a third of the world's population. It is the 6th most important crop in terms of agricultural productivity. Kodo millet, proso millet, pearl millet, barnyard millet, small millet, finger millet, foxtail millet, and sorghum are examples of millets. Millets come in a variety of kinds that are utilised in different parts of India [1]. Millet grains are ancient crops and perhaps the earliest cereal grain known to humans for domestic use; they are small-seeded, round-shaped cereals that belong to the Poaceae family [2].

When compared to the nutritional content of commonly consumed grains such as rice and wheat, all millets have a three-to-five-fold higher nutritious value [1]. Millets are high in carbs, proteins, lipids, vitamins, minerals, and bioactive substances, among other nutrients [2, 16].

Millets are rich in vitamins, minerals with low content of fat, glycemic index and dietary energy, hence they have been observed to have numerous health benefits. The epidemical evidence showed there is a very close association with millets in reducing the incidence or the risk factors of diabetes, cardiovascular diseases and certain types of cancers etc. [5, 13, 14]. Millets are known for their good nourishing properties which helps in addressing the malnutrition. They are consumed in different ways like flour, parboiled, rolled into balls and served as porridge with the milk [17]. Millet based foods are considered as potential prebiotic and pro- biotics with prospective health benefits [2, 11]. Millet grains are widely consumed as a source of traditional medicines and are important food to preserve health. The phytonutrients and vitamins may be responsible for the antioxidant, anticancer and anti-inflammatory, antifungal, and blood clot inhibition properties of millet crops [4, 10]. Millets are highly nutritious, non-glutinous and non-acid forming foods. Hence, they are soothing and easy to digest. They are considered to be the least allergenic and easily digestible grains available. Millets contain about 8 per cent protein and 4 per cent fat. Millets are especially rich in calcium. The dietary carbohydrate content of millets is also relatively high. Starch is the main carbohydrate component, and they contain a higher proportion of non-starchy polysaccharides (dietary fiber) also [8]. As the millets are consumed by the poor, they guard them against food and nutritional insecurity imposed by various agronomic, socio-economic and political factors. Therefore, millets act as a shield against nutritional deficiency disorders and provide nutritional security [12]. Hence the preset study was undertaken to observe the physical, functional properties of sprouted and un sprouted millets and their end use for acceptability traditional product.

# 2 Materials and Methods

## 2.1 Procurement of materials

Pearl millet, proso millet, foxtail millet and barnyard millet were obtained from the Kolar local market, Karnataka, India and stored in the room temperature till the further experiments are conducted. The half quantity of millets was roasted and powdered and sieved. The other half quantity of the millets was soaked and allowed for sprouting. After the millets are sprouted, they were dried in the sunlight and made into powder. And these powdered millets were used for the study and development of laddus.

### I. Physical properties

Physical properties like thousand grain weight, thousand grain volume, bulk density and colour were assessed for millet grains.

- **Thousand grain weight (g):**Three sets of 1000 intact grains were selected randomly. The mean weight was expressed in g/1000 grains. Weight of selected grains was recorded in triplicates using electronic weighing balance and average was calculated.
- **Thousand grain volume (ml):**The volume of millet grains was measured by water displacement method. Thousand randomly selected grains were dropped in measuring cylinder containing known volume of water. The raise in volume was recorded in ml. The volume of millet was calculated by subtracting the initial volume from final volume.
- **Bulk density:** Bulk density was calculated from weight by volume of the millets.

### II. Functional properties

Functional properties like hydration capacity, hydration index, swelling capacity and swelling index were assessed for millet grains.

- **Hydration capacity (g/1000 grains):** Hydration capacity was measured by soaking weighed 1000 millets overnight in a beaker with 100ml of water. Next day water was drained off, and millets were dried using filter paper to remove superfluous water and weighed [3]. Hydration capacity was calculated as

$$\text{Hydration capacity of seeds} = \frac{weight\ after\ soaking\ (g) - weight\ before\ soaking\ (g)}{number\ of\ seeds\ (1000 grains)}$$

- **Hydration index:** Hydration index was calculated using formula

$$\text{Hydration index} = \frac{hydration\ capacity}{weight\ of\ seeds}$$

- **Swelling capacity (ml/ 1000 grains):** Thousand grains were counted, and volume was noted by water displacement method. The grains were soaked overnight. Further, water was drained off next day, and volume was note [3]. The swelling capacity was measured using formula

$$\text{Swelling capacity} = \frac{volume\ of\ seeds\ after\ soaking\ (ml) - volume\ of\ seeds\ before\ soaking\ (ml)}{number\ of\ seeds\ (1000\ grains)}$$

- **Swelling index:** Swelling index was calculated using formula

$$\text{Swelling index} = \frac{swelling\ capacity}{volume\ of\ seeds}$$

### III. Physical properties of partitioned millets

- **Particle size:** Hundred grams of flour was weighed and passed through different meshes of BSS sieves from 60, 85, 100, 150, 200, 240 and 300 with sieve opening of 250, 180, 150, 105, 75, 63 and 535 microns respectively. The samples were passed from bigger to smaller mesh size. The sample above the mesh was weighed and the reading was recorded. Percentage was calculated.
- **Tapped bulk density (g/ml):** A standard graduated cylinder of 100 ml capacity was taken for the bulk density measurement. Initially, the empty measuring cylinder was weighed, and then 20g of flour was added in the cylinder then tapped for 20-25 times to a vertical distance of 20 mm to pack the flour particles tightly and recorded the volume of weighed sample. The tapped bulk density (TBD) of flour was determined by following formula [6].

$$\text{Tapped bulk density (g/ml)} = \frac{weight\ of\ the\ sample\ at\ recorded\ volume\ (g)}{volume\ of\ sample\ (ml)}$$

- **Loose bulk density:** Loose bulk density of flours was determined by pouring flour sample into a a10 ml graduated measuring cylinder. Weight of the sample was measured when the sample volume reached 1 ml. The loose density was calculated by dividing weight with the volume of the obtained powder [6].

$$\text{Loose bulk density (g/ml)} = \frac{weight\ of\ the\ flour\ at\ 1\ ml}{volume\ of\ the\ sample\ (1\ ml)}$$

### IV. Functional properties

- **Water absorption capacity:** Water absorption capacity was assessed by the method of [19]. Five grams of flour was weighed and added to the pre weighed centrifuge tube ($W_1$) and stirred with a glass rod for 5 min. The contents were allowed to stand for 30 min and centrifuged at 11000 rpm for 25 min. The free liquid was poured off. Inner side of tube was wiped off with tissue paper. The centrifuge tube was weighed again ($W_2$). The water absorption capacity was calculated using the formula

$$\text{Water absorption capacity, WAC (\%)} = \frac{W2-W1}{5} \times 100$$

- **Oil absorption capacity:** Oil absorption capacity was assessed by using [18, 19] method. 1 gram of flour was mixed with 10 ml of refined vegetable oil in pre-weighed centrifuge ($W_1$). The tubes were stirred for one min for complete dispersion of sample, and the sample was centrifuged at 3000 rpm for 25 min. The separated oil was then removed, and tubes were inverted on absorbent paper to drain off the remaining oil prior to reweighing ($W_2$). The absorption capacity was calculated using formula

$$\text{Oil absorption capacity, OAC (\%)} = \frac{W2 - W1}{1} \times 100$$

- **Swelling power:** Swelling power was estimated as per [17]. Five hundred milligram ($W_1$) of the sample was weighed, placed into centrifuge tube and the centrifuge tube with sample was weighed ($W_2$). Twenty ml of distilled water was added ($V_E$) and heated for 30 min in a water bath at $90^0$C, with occasional stirring, the tubes were cooled and centrifuged at 5000 rpm for 10 min. The supernatant was decanted into a pre-weighed ($W_4$) Petri plate and dried at $105^0$C and weighed ($W_5$). The inner side of the centrifuge tube was wiped, dried and weighed ($W_3$). Percent swelling power was calculated using the following formula

$$\text{Swelling power (g/g)} = \frac{W_3 - W_2}{W_1} \times 100$$

- **Percent Dispersibility:** Ten grams of sample was weighed accurately, transferred to 100ml stoppered measuring cylinder. Hundred ml distilled water was added to measuring cylinder, stirred vigorously and allowed to settle for three hours. The volume of settled particles was recorded and subtracted from 100. The difference was recorded as per cent dispersibility [9].
- **Wettability:** Two grams of the sample was weighed and transferred to a beaker containing 80ml water. The behavior of the powder was observed on the water surface immediately after adding the sample. After 30 min observation, the material was stirred on the magnetic stirrer sufficiently fast to form a vertex which reached the bottom of the beaker and the stirring continued for one min, after which the grade describing wettability was recorded as excellent, good, fair and poor according to the time and behavior of the dispersion.

- **Flowability [Carr Index (CI)]:** The flowability of flour was expressed as Carr Index (CI) in terms of tapped density (pT) and bulk density (pB) as described by [9].

$$CI = \frac{pT\ (Tapped\ density - pB\ (bulk\ density)}{pT\ (Tapped\ density)} \times 100$$

Classification of flour flowability based on Carr Index (CI)

| CI% | Flowability |
|---|---|
| < 15 | Very good |
| 15-20 | Good |
| 20-35 | Fair |
| 35-45 | Bad |
| >45 | Very bad |

- **Cohesiveness (Hausner Ratio):** Cohesiveness of the flour was evaluated in terms of Hausner ratio (HR), calculated from bulk density (pB) and tapped density (pT) as suggested by [15].

HR = pT/Pb

Classification of flour cohesiveness based on Hauser Ratio (HR)

| Hauser ratio | Cohesiveness |
|---|---|
| <1.2 | Low |
| 1.2-1.4 | Intermediate |
| >1.4 | High |

- **Gelation temperature:** Six per cent aqueous solution of flour/starch was prepared into a beaker. The solution was heated in boiling water bath with constant stirring until the solution gets gelatinized. At the point of gelatinization, the temperature was noted with thermometer. Time required for the initiation of gelatinization was recorded.
- **Percent sag:** Six per cent starch/flour solution was prepared and cooked. The gelatinized solution was poured into a cup, and it was placed in refrigerated for one hour. After cooling the height of the gel was measured in the cup with toothpick and scale. Cooled gel was inverted on flat surface; again, height was measured with toothpick and scale. The per cent sag was calculated using the formula

$$\text{Percent sag} = \frac{Initial\ height\ in\ cup - final\ height\ on\ flat\ surface}{initial\ height\ in\ cup} \times 100$$

- **Paste clarity:** A 0.5 per cent (dry basis, w/v) aqueous suspension of starch/flour was prepared and heated in boiling water bath for 30 min with constant stirring. The mixture was cooled to room temperature. The transmittance of the paste was measured at 650nm against a water blank using spectrophotometer [19].
- **Viscosity:** Viscosity for five per cent aqueous solution of sample was determined using Brookfield viscometer (VII), spindle No.2 and speed 60 RPM at 31$^0$C and viscosity was expressed as centipoises (cP). Viscosity was also measured for hot slurries after heating them at 70$^0$C for 15 min.

# 3 Results and Discussion

**Table 1: Physical properties of different millets grains**

| Physical properties | Millet grains | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Pearl millet | | Proso millet | | Foxtail millet | | Barnyard millet | |
| | USM | SM | USM | SM | USM | SM | USM | SM |
| TKW (g) | 10.2±0.15 | 14.4±0.38 | 5.8±0.05 | 6.72±0.09 | 2.89±0.08 | 4.65±0.62 | 2.22±0.08 | 3.49±0.40 |
| P >0.005 | 0.002 | | 0.002 | | 0.049 | | 0.028 | |
| TKV (ml) | 14.5±0.2 | 22.8±0.76 | 8.1±0.2 | 8.56±0.41 | 5.26±0.15 | 6.36±0.25 | 3.56±0.25 | 5.46±0.35 |
| P >0.005 | 0.001 | | 0.073 | | 0.041 | | 0.025 | |
| BD(g/ml) | 0.70±0.01 | 0.65±0.04 | 0.72±0.01 | 0.82±0.05 | 0.55±0.02 | 0.78±0.11 | 0.62±0.06 | 0.68±0.06 |
| P >0.005 | 0.215 | | 0.093 | | 0.106 | | 0.307 | |

TKW- thousand kernel weight, TKV- thousand kernel volume, BD- bulk density

**Table 2: Functional properties of different millets grains**

| Millet grains | Functional properties | | | |
|---|---|---|---|---|
| | HC (g/1000grains) | HI | SC (ml/1000grains) | SI |
| Unsprouted | | | | |
| Pearl millet | 2.64±0.43 | 29.13±0.25 | 7.4±0.30 | 50.9±0.3 |
| Proso millet | 0.86±0.04 | 15.2±0.35 | 0.4±0.15 | 3.74±0.11 |
| Foxtail millet | 0.37±0.05 | 10.62±0.19 | 0.2±0.15 | 1.67±0.22 |
| Barnyard millet | 0.34±0.05 | 13.36±0.39 | 1.5±0.1 | 39.5±2.77 |

HC- hydration capacity, HI- hydration index, SC- swelling capacity, SI- swelling index

**Table 3: Physical properties of flour of different millets flours**

| Physical properties | Millet flour | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Pearl millet | | Proso millet | | Foxtail millet | | Barnyard millet | |
| | USM | SM | USM | SM | USM | SM | USM | SM |
| PS | 1.33±0.25 | 1.6±0.23 | 1.43±0.20 | 1.6±0.2 | 1.46±0.30 | 1.7±0.26 | 0.9±0.1 | 1.2±0.26 |
| P >0.005 | 0.184 | | 0.370 | | 0.118 | | 0.095 | |
| TBD (g/ml) | 1.8±0.13 | 0.64±0.05 | 1.83±0.06 | 0.76±0.05 | 1.83±0.07 | 0.67±0.03 | 1.86±0.05 | 0.77±0.05 |
| P >0.005 | 0.009 | | 0.004 | | 0.003 | | 0.003 | |
| LBD(g/ml) | 0.53±0.05 | 0.35±0.02 | 0.37±0.01 | 0.37±0.05 | 0.47±0.03 | 0.39±0.06 | 0.43±0.04 | 0.37±0.02 |
| P >0.005 | 0.010 | | 0.932 | | 0.070 | | 0.059 | |

PS- particle size, TBD- tapped bulk density, LBD- loose bulk density

**Table 4: Functional properties of flour of different millet flours**

| Functional properties | Millet flour | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Pearl millet | | Proso millet | | Foxtail millet | | Barnyard millet | |
| | USM | SM | USM | SM | USM | SM | USM | SM |
| WAC (ml/100g) | 102.6±1.52 | 110±1.67 | 77.4±1.20 | 69.8±2.35 | 103.9±2.56 | 114.1±2.58 | 86.6±2.51 | 68±1.63 |
| P >0.005 | 0.007 | | 0.008 | | 0.030 | | 0.003 | |
| OAC (ml/100g) | 88.4±0.85 | 85.2±3.12 | 95.4±4.05 | 92.1±1.53 | 89.0±3.56 | 86.4±2.21 | 92.6±2.04 | 91.5±2.70 |
| P >0.005 | 0.291 | | 0.280 | | 0.337 | | 0.720 | |
| SP (g/g) | 5.7±0.40 | 4.9±0.2 | 9.1±0.25 | 5.4±0.41 | 4.9±0.32 | 4.5±0.40 | 5.2±0.3 | 4.7±0.30 |
| P >0.005 | 0.046 | | 0.010 | | 0.377 | | 0.096 | |
| PD (%) | 79±2 | 74.3±3.51 | 81±2 | 81.3±3.21 | 79.3±2.51 | 78±3 | 83.6±3.21 | 80±2 |
| P >0.005 | 0.229 | | 0.921 | | 0.667 | | 0.212 | |
| WE | Good | Good | Excellent | Excellent | Fair | Fair | Excellent | Good |
| FL (CARR index) | Very bad | Bad | Very bad | Very bad | Very bad | Bad | Very bad | Very bad |
| COH (hauser ratio) | Low | Low | Low | Low | Low | Low | Low | Low |
| GT ($^{O}$C) | 87.2±2.62 | 82.8±2.72 | 78.9±2.57 | 76.6±2.45 | 81.6±2.20 | 78.3±3.37 | 89.0±1.62 | 86.2±1.91 |
| P >0.005 | 0.251 | | 0.505 | | 0.048 | | 0.073 | |
| PS (%) | 8.53±0.5 | 14.2±0.4 | 6.06±0.37 | 8.93±0.70 | 8.36±0.92 | 14.8±0.6 | 15.9±0.25 | 5.26±0.60 |
| P >0.005 | 0.002 | | 0.010 | | 0.007 | | 0.001 | |
| PC | 56.2±1.37 | 78.6±1.20 | 44.1±2.58 | 75.2±1.35 | 66.1±1.41 | 66.9±2.13 | 54.06±1.60 | 55.2±1.34 |
| P >0.005 | 0.004 | | 0.001 | | 0.305 | | 0.569 | |
| V(cP) | 5.62±0.47 | 8.10±0.26 | 2.94±0.16 | 4.29±0.82 | 5.32±0.50 | 5.20±0.97 | 4.05±0.25 | 4.01±0.84 |
| P >0.005 | 0.024 | | 0.099 | | 0.897 | | 0.918 | |

WAC- water absorption capacity, OAC- oil absorption capacity, SP- swelling power, PD- percent dispersibility, WE-wettability, FL- flowability, COH- cohesiveness, GT- gelation temperature, PS- percent sag, PC-paste clarity, V- viscosity

**Table 5: Sensory evaluation**

| Laddus prepared from: | Sensory evaluation | | | | |
|---|---|---|---|---|---|
| | Colour | Texture | Taste | Flavor | Overall acceptability |
| Non-sprouted | 7.5±0.6 | 7.9±0.7 | 7.8±1.0 | 7.7±0.7 | 7.8±0.7 |
| Sprouted | 7.7±0.6 | 7.9±0.8 | 7.7±1.3 | 7.5±0.7 | 8±1.1 |

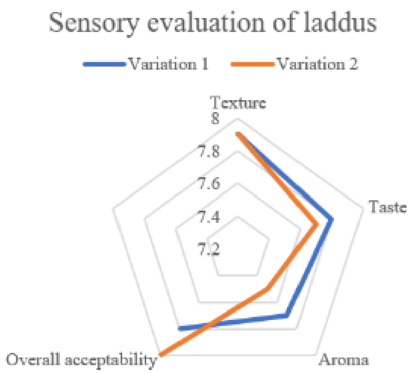


**Fig. 1: Radar chart representing the results of sensory evaluation of sprouted and unsprouted millet laddus**

Table. 1 shows the physical properties of millet grains. The physical parameters studied were thousand grain weight, thousand grain volume and bulk density. The thousand kernel weight and thousand grain volume of sprouted millets were found to be higher than the unsprouted millets. The bulk density of sprouted millets was also higher than unsprouted millets except for proso millet.

Table. 2 shows the functional properties of millet grains. The functional properties studied were hydration capacity, hydration index, swelling capacity and swelling index.

Table. 3 shows the physical properties of millet flours. The physical properties studied were particle size, tapped bulk density and loose bulk. The particle size and loose bulk density of sprouted millets were found to be higher than unsprouted millets. The tapped bulk density of unsprouted millets were higher than sprouted millets.

Table. 4 shows the functional properties of millet flours. the functional properties studied were water absorption capacity, oil absorption capacity, swelling power, dispersibility, wettability, flowability/CARR index, cohesiveness, gelatinization, percent sag, paste clarity and viscosity. The water absorption capacity of unsprouted pearl and foxtail millet was higher than sprouted millets and sprouted proso and barnyard millets were found to be higher than unsprouted millets. The oil absorption capacity, swelling power, percent dispersibility and gelation temperature of unsprouted millets were found to be higher than the sprouted millets. The percent sag, paste clarity and viscosity of sprouted millets were found to be higher than unsprouted millets.

## 4 Conclusion

The sensory evaluation showed more acceptability with functional components of sprouted millet laddu. Due to the decrease in antinutritive value and more acceptability sprouted millet laddu can be recommended than unsprouted millet laddu to the public.

### 4.1 Recommendations

The study can be expanded to know the difference in the polyphenols, amino acid profile and amino acid score present in the sprouted and unsprouted millet laddus.

## References


1. Ambati K, Sucharitha KV. Millets - review on nutritional profiles and health benefits. *International Journal of Recent Scientific Research*. 2019;10(7):33943-33948. Available from: 10.24327/ijrsr.2019.1007.3786
2. Banerjee S. Finger Millet (*Eleusine Coracana*) Polyphenols: investigation of their antioxidant capacity and antimicrobial activity. *African Journal of Food Science*. 2012;6(13):362–374. Available from: 10.5897/ajfs12.031
3. Bhokre CK, Joshi AA, Rodge AB. Determination of physico-chemical and functional properties of different genotypes of horse gram. *Asian Journal of Dairy and Food Research*. 2015;34(4):307–313. Available from: 10.18805/ajdfr.v34i4.6884
4. Dykes L, Rooney LW. Phenolic Compounds in Cereal Grains and Their Health Benefits. *Cereal Foods World*. 2007;52(3):105–111. Available from: 10.1094/cfw-52-3-0105
5. Gong L, Cao W, Chi H, Wang J, Zhang H, Liu J, *et al*. Whole cereal grains and potential health effects: Involvement of the gut microbiota. *Food Research International*. 2018;103:84-102. Available from: 10.1016/j.foodres.2017.10.025
6. Goula AM, Karapantsios TD, Achilias DS, Adamopoulos KG. Water sorption isotherms and glass transition temperature of spray

dried tomato pulp. *Journal of Food Engineering*. 2008;85(1):73-83. Available from: 10.1016/j.jfoodeng.2007.07.015

7. Jinapong N, Suphantharika M, Jamnong P. Production of instant soymilk powders by ultrafiltration, spray drying and fluidized bed agglomeration. *Journal of Food Engineering*. 2008;84(2):194-205. Available from: 10.1016/j.jfoodeng.2007.04.032
8. Khatoniar S, Das P. Physical and Functional Properties of Some Millet Varieties of Assam. *International Journal of Current Microbiology and Applied Sciences*. 2020;9(5):1508-1515. Available from: 10.20546/ijcmas.2020.905.171
9. Kulkarni KD, Kulkarni DN, Ingle UM. Sorghum Malt-Based Weaning Food Formulations: Preparation, Functional Properties, and Nutritive Value. *Food and Nutrition Bulletin*. 1991;13(4):1-7. Available from: 10.1177/156482659101300401
10. Nithiyanantham S, Kalaiselvi P, Mahomoodally MF, Zengin G, Abirami A, Srinivasan G. Nutritional and functional roles of millets —A review. *Journal of Food Biochemistry*. 2019;43(7):1–10. Available from: 10.1111/jfbc.12859
11. Palaniswamy SK, Govindaswamy V. In-vitro probiotic characteristics assessment of feruloyl esterase and glutamate decarboxylase producing Lactobacillus spp. isolated from traditional fermented millet porridge (kambu koozh). *LWT - Food Science and Technology*. 2016;68:208-216. Available from: 10.1016/j.lwt.2015.12.024
12. Pradeep PM, Sreerama YN. Impact of processing on the phenolic profiles of small millets: Evaluation of their antioxidant and enzyme inhibitory properties associated with hyperglycemia. *Food Chemistry*. 2015;169:455-463. Available from: 10.1016/j.foodchem.2014.08.010
13. Singh P, Raghuvanshi RS. Finger millet for food and nutritional security. *African Journal of Food Science*. 2012;6(4):77–84. Available from: 10.5897/ajfsx10.010
14. Radhika G, Sathya RM, Ganesan A, Saroja R, Vijayalakshmi P, Sudha V, *et al*. Dietary profile of urban adult population in South India in the context of chronic disease epidemiology (CURES – 68). *Public Health Nutrition*. 2011;14(4):591-598. Available from: 10.1017/s136898001000203x
15. Sosulski FW, Elkowicz L, Reichert RD. Oligosaccharides in Eleven Legumes and Their Air-Classified Protein and Starch Fractions. *Journal of Food Science*. 1982;47(2):498-502. Available from: 10.1111/j.1365-2621.1982.tb10111.x
16. Srilekha K, Kamalaja T, Maheswari KU, Rani RN. Evaluation of physical, functional and nutritional quality parameters of Kodo millet flour. *Journal of Pharmacognosy and Phytochemistry*. 2019, 8(4): 192–195.
17. World Food Summit: Five Years Later (Rome, 10 to 13 June 2002). *Food and Agriculture Organisation of the United Nations (FAO)*. 2002. 12–14.
18. Wu Y, Lin Q, Cui T, Xiao H. Structural and Physical Properties of Starches Isolated from Six Varieties of Millet Grown in China. *International Journal of Food Properties*. 2014;17(10):2344-2360. Available from: 10.1080/10942912.2013.803119
19. Yousaf L, Hou D, Liaqat H, Shen Q. Millet: A review of its nutritional and functional changes during processing. *Food Research International*. 2021;142:110197. Available from: 10.1016/j.foodres.2021.110197