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Morphological and functional characteristics of under-utilized crops of Himachal Pradesh

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Abstract
The present study was undertaken with the objectives to investigate the physical, functional and morphological properties of three under-utilized crops namely, amaranth, buckwheat and ricebean. With over most of humanity's energy and protein requirements are being met by three main crops, maize, wheat and rice, population faces a very vulnerable situation and there is urgent need to enhance crop diversification. Under-utilized crops are often rich in nutrients when compared to more popular staple crops so these three were analyzed for some physical properties like length, weight, 1000 kernel weight, angle of repose and some functional characteristics like bulk and true density, porosity, emulsion stability etc. In regard to morphological properties scanning electron microscopy (SEM) was conducted to understand the structure of these crops. It was observed that 1000 kernel weight was found to be maximum in ricebean v.i.z. 64.52 gm and angle of repose was maximum in ricebean (26.46°). Values of porosity in amaranth, buckwheat and ricebean were 28.67, 44.62 ad 43.8 percent respectively. So, this was proved that these traditional crops are highly nutritious and acceptable for the whole mass of population.

Keywords: Traditional crops, amaranth, ricebean, nutrients, morphological, diversification, vulnerable and population

1. Introduction

Underutilized crops which are domesticated plant species used for centuries for food, but over time they have reduced their importance as well as cultivation. These crops have multiple usage and untapped potentials for nutritional improvement of population and contribute to fight malnutrition.

These crops possess promising nutritional and industrial importance for a variety of purposes for human kind. Their cultivation is restricted to specialized geographical pockets in different agro ecological regions, mainly by poor farming communities which derive their sustenance and livelihood from such crops. However the commercial importance and market value of these crops are still unknown to the public (Joshi *et al*. 2002). Biodiversity International, International Centre for Underutilized crops (ICUC) and National Academy of Sciences (NAS, USA) identified 200 such underutilized crop species (29 millets, 10 oilseeds, 27 pulses, 25 root and tuber crops, 52 fruits and nuts, 24 minor fruits, 39 vegetables and 5 fibre and pulp yielding plants) for different eco-geographical region of the world (Eyzaguirre *et al.* 1999). Underutilized crops are domesticated species of plants that are grown for food but have been ignored due to various reasons; for example, adaptation to different growing conditions, ease in cultivation and storage of the crop, its nutritional characteristics and taste, social taboos (Padulosi *et al*. 2002, Virchow 2008, Mayes *et al*. 2012, Cernansky 2015) [15]. Instead the inborn properties that have made potential food crops underutilized, they can play important part in increasing essential micronutrients nutritional food scarcity (Vuong 2000, Gupta *et al*. 2005, Khoo *et al*. 2008, Padulosi *et al*. 2008, Arivalagan *et al*. 2012, Ebert 2014, Galluzzi and Noriega 2014). Worse still, their view as 'food of the poor' often stigmatize them, creating a financial disadvantage for their production and consumption. The underutilized crops also has promising economic value and economically important for medicinal value and found in high altitude regions of Himachal Pradesh, Jammu and Kashmir and Garwhal and Kumaon regions of Uttrakhand. In Himachal the distribution of underutilized crops is mainly to the Lahaul and spiti and Kinnaur districts and parts of Pangi and Bharmour Tehsils of Chamba district. Even in north east India various lesser known crops are used by tribal people such as leaves of chenopodium and amaranth.

Among different underutilized crops, some crops grown in different regions are amaranth, buckwheat, horsegram, ricebean black cumin and finger millet have recently gained the attention as supplementary food crops. These poses immense potential due their nutritional quality, high grain yield and multipurpose usages (Aarthi *et al*. 2003). So these crops do have great potential to play many roles in improvement of food security and to utilize these species having comparatively more advantages in providing better food which is affordable by poor. Buckwheat, amaranth, rice bean and adzuki bean are amongst potential crops which have high nutritional and medicinal value and have potential for adding in weaning foods for improving nutritional, functional and sensory acceptability of the formulated value added products.

Among these crops Amaranth (*Amaranthus caudatus*) is mainly grown in Kinnaur, Kullu and Sirmour districts of Himachal Pradesh (Mohil and Jain, 2012). The grain has high level of protein, as well as as appreciable amount of fat content and has the potential to use it as an energy giving food. The balance of carbohydrates, fats, and protein, allow amaranth the chance to achieve a balanced nutrient uptake level with decreased amounts of consumption than with other cereals. The amaranth grain is also high in minerals such as calcium, magnesium, phosphorus, as well as dietary fibre.

Rice bean [*Vigna umbellata*] is also called by the name climbing mountain bean, mambi bean, oriental bean and red bean. It is mainly grown in Kangra district of Himachal Pradesh and is one of best legume, rich in protein content (21-25%) and amino acid, especially the limiting amino acids which includes, methionine and tryptophan and considerably increased quality of vitamins as well as minerals. Buckwheat (*Fagopyrum esculentum)* is an important source of proteins, fibers, vitamins and minerals, such as iron, manganese, phosphorus and selenium. Some buckwheat components, such as proteins has valuable cholesterol lowering properties and remarkable outstanding health enhanced properties (Christa and Soral-Smentana, 2008).

2. Materials and methods

Three under-utilized crops Ricebean, Amaranth and Buckwheat were obtained from Department of Organic Agriculture, CSKHPKV, Palampur and Regional Research Station, Sangla.

2.1 Preparation of the samples

The obtained seed samples were sorted and cleaned by hands to remove present dirt, dust and foreign particles if present. Then the seeds further were grounded in to very fine coarse powder with the support of stainless steel mixer and stored in airtight containers so as to reduce changes till further analysis.

2.2 Physical parameters

2.2.1 Color and Shape

The color determinations were carried out by using a reflectance colorimeter KONICA MINOLTA, Chroma- Meter CR-400. The values were expressed as Chromatic components, L*, a* and b*. L* values correspond to lightness/darkness and extends from 0 (black) to 100 (white) with higher values corresponds to more lightness. The a* and b* values corresponds to sample's color dimensions, with a* values describing sample's red (+a) to greenness (-a), while b* values describe the sample's yellow (+b) to blueness (-b). Larger the a* values indicate more redness and larger the b* values indicate more yellowness. The shape of the millet grains were observed from their physical appearance through visual perception.

2.2.2 Size

The size of millet grains was measured in terms of length, breadth and thickness with the help of Vernier Caliper. Ten grains in triplicate were taken and length, breadth and thickness were measured.

2.2.3 Thousand grain weight

Representative samples of each crop were drawn randomly and thousand grains weight were recorded in grams/1000 kernels by counting grains and weighing on electrical balance.

2.2.4 Angle of Repose

It is the steepest angle between the base and slope of cone formed on a free vertical fall of grain mass to a horizontal plane when material is free falling or sliding. It was determined by making a circular pile of the grains freely falling. The height of the pile was taken (h) and its radius (r) is also taken. Angle of repose was then calculated by following formula.

Angle of Repose = tan (h/r)

2.3 Functional Properties

2.3.1 Bulk Density (Grains and flour)

The millet grains and flour were filled separately in measuring cylinders up to certain level from the constant height followed by weighing. The bulk density was determined by using the formula

Weight (g) Bulk density = Volume (ml)

2.3.2 True density

The true density was measured by toluene displacement method. One thousand grains of millets were weighed and put in graduated cylinder contain known amount of toluene and rise in toluene level was noted.

Weight (g) True density = Volume (ml)

Where, W is weight of one thousand grains and V is rise in toluene level after adding the grains.

2.3.3 Porosity

Porosity was analyzed by using the relationship of bulk density and true density. Porosity = (true density – bulk density)/ true density x 100

2.3.4 Water Absorption (Sathe and Salunkhe, 1981)

Water absorption capacity was determined using the method of Sathe and Salunkhe (1981) with slight modifications. 10 ml of distilled water was added to 1.0 g of the sample in a beaker. The suspension was stirred using a stirrer for 5 minutes. The suspension obtained was thereafter centrifuged at 3555 rpm for 30 min and the supernatant measured in a 10 ml graduated cylinder. Water absorbed was calculated as the difference between the initial volume of water added to the sample and volume of the supernatant.

2.3.5 Oil Absorption (Sathe and Salunkhe, 1981)

Oil absorption capacity was determined using the method of Sathe and Salunkhe (1981) with slight modifications. 10 ml of oil was added to 1.0 g of the sample in a beaker. The suspension was stirred using a stirrer for 5 minutes. The suspension obtained was thereafter centrifuged at 3555 rpm for 30 min and the supernatant measured in a 10 ml graduated cylinder. Oil absorbed was calculated as the difference between the initial volume of water added to the sample and volume of the supernatant.

2.3.6 Emulsion Stability

The emulsion stability was calculated by Yasumatsu *et al*. (1972) described and followed as the emulsion (1 g sample, 10 ml distilled water and 10 ml oil) was prepared in calibrated centrifuged tube. The emulsion was centrifuged at 2000 × g for 5 min. The ratio of the height of emulsion layer to the total height of the mixture was calculated as emulsion activity in percentage. The emulsion stability was estimated after heating the emulsion contained in calibrated centrifuged tube at 80°C for 30 min in a water-bath, cooling for 15 min under running tap water and centrifuging at 2000 × g for 15 min. The emulsion stability expressed as percentage was calculated as the ratio of the height of emulsified layer to the total height of the mixture.

3. Results and discussion

3.1 Physical characteristics of under-utilized crops of H.P

3.1.1 Shape

Amaranth were round in shape as presented in table 4.1. Similar results were shown by Haupatli (1980) [10] in amaranth who reported the shape of seeds were round. Further ricebean and buckwheat seeds were longitudinal and triangular respectively. Shweta (2013) [23] also reported that the shape of the rice bean was longitudinal.

3.1.2 Length

As it is clear from data in table 4.1 that seed length of ricebean was significantly higher (5.42 mm) as compared to other seeds i.e. buckwheat (2.56 mm), and amaranth (1.43 mm) respectively. The results of present study are in agreement with finding of Joshi *et al.* (2007) [11] while studying ricebean reported that average length of ricebean seed was 6.1 mm. Similar results were shown by Abalone *et al*. (2004) for amaranth who reported that the average length seeds were 1.42 mm respectively. The slight variation in the result of present investigation might be due to different cultivars or varieties used in current study.

3.1.3 Diameter

The values diameter of ricebean was 2.95 mm followed by buckwheat and amaranth which was 2.83 mm,
1.23 mm respectively as presented in table 1. Similar results were shown by Joshi *et al*. (2007) [11] who while studying "Ricebean: a multipurpose underutilized legume" reported that average width of seed was 3.3 mm. Akubugwo *et al*. (2007) [1] studied that the seeds of amaranth are small and lenticellular in shape with each seed averaging 1-1.5 mm in diameter whose results were found to be similar.

Table 1: Physical characteristics of under-utilized crops of H.P

Parameters	Amaranth	Buckwheat	Ricebean
Color	L*-79.64, a*-4.9, b*-17.29	L*-72.43, a*-1.72, b*-11.93	L*-83.89, a*-1.71, b*-14.2
Shape	Round	Triangular	Longitudnal
Length	1.43	2.56	5.42
Width	1.23	2.83	2.95
L/B Ratio	1.15	0.9	1.83
1000 Kernel weight	1.13	24.17	64.52
Angle of Repose	26.44	24.48	26.46

Table 2: Functional characteristics of under-utilized crops of H.P

Parameters	Amaranth	Buckwheat	Ricebean
Bulk Density (g/ml)	0.82	0.67	0.8
True Density (g/ml)	1.15	1.21	1.13
Porosity (%)	28.67	44.62	43.58
WaterAbsorption (g/ml)	1.9	2.5	2.7
Oil Absorption (g/ml)	3.4	2.6	2.4
EmulsionStability (%)	66.7	62.8	65.1

3.1.4 1000 kernel weight

It indicates the results for 1000 kernel weight of Amaranth, Buckwheat and Rice bean. The highest seed weight was recorded in rice bean i.e. 64.52 gm followed by buckwheat i.e. 24.17 gm. Similar results were shown by Awasthi *et al*. (2011) [3] who reported 1000 kernel weight of ricebean varieties ranged between 68.00 to 74.00 gm. The results of buckwheat, amaranth and ricebean were 64.52 gm, 24.17 gm and 1.13 gm respectively and Jain and Haupatli (1980) [10] also reported the 1000 kernel weight of amaranth ranged from 0.6 to 1.2 gm. Riechert *et al*. (1986) analysed various varieties of quinoa seeds and reported average weight of 1000 seeds in range of 1.99 to 5.08 gm. The results were found to be significant with ;2each other. In present study difference might have been due to different cultivars and agroclimatic conditions.

3.1.5 Angle of repose

Angle of repose represents the smoothness of seed surface and has marked effect on transportation of seeds. The angle of repose is of paramount importance in the design of hopper openings, side walls and storage structures in the bulk of grains per ramp (Solomon and Zewdu, 2009). The experimental results of angle of repose were maximum in ricebean (26.46°), followed by amaranth (26.44°) and minimum in buckwheat (24.48°). A significant decrease of angle from 26.43° to 24.60° ($p \leq 0.01$) with moisture content from 7 to 21% wb was observed by Kudos and Solanki (2018). [26]. Similar results were observed by Bhavsar *et al*. (2013) who observed 24o 52′ as value for angle of repose of buckwheat. These results are in good agreement with the observations of present investigation.

3.1.6 Colour

It was noticed that the lightness (*L**) of the amaranth flour is 79.64. The reducing values of *L** indicates the flours are darker in color. On the other hand, a reverse trend was noticed for redness (*a**) and yellowness (*b**) in flours. The increase in *a** and *b** values was noticed as amaranth flour 4.9 and 17.29 respectively and lower in buckwheat an ricebean i.e. a*1.72, b*11.93 and a*-1.71, b* 4.2 respectively.

3.2 Functional properties

3.2.1 Bulk density

The bulk density of seeds varied which was highest in amaranth (0.82 g/ml) followed by ricebean (0.8 g/ml) and lowest in buckwheat (0.67 g/ml) and similar results were observed by Kudos and Solanki (2018) whose values for amaranth grains varied significantly ($p \leq 0.01$) from 0.81to 0.83 g/ml and in Quequeto *et al*. (2018) buckwheat from 0.63-0.66 g/ml

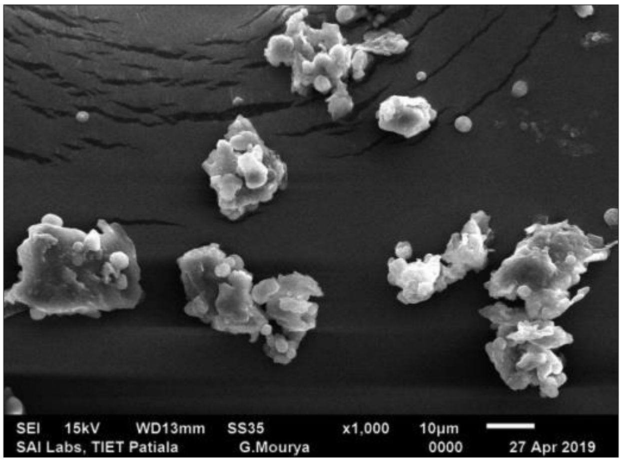
3.2.2 True Density

The highest true density was found to be in ricebean (1.21 g/ml) followed amaranth (1.15 g/ml) and least in ricebean (1.13 g/ml). Similar results in buckwheat were observed by Quequeto *et al*. (2018) as 1.089to 1.252.

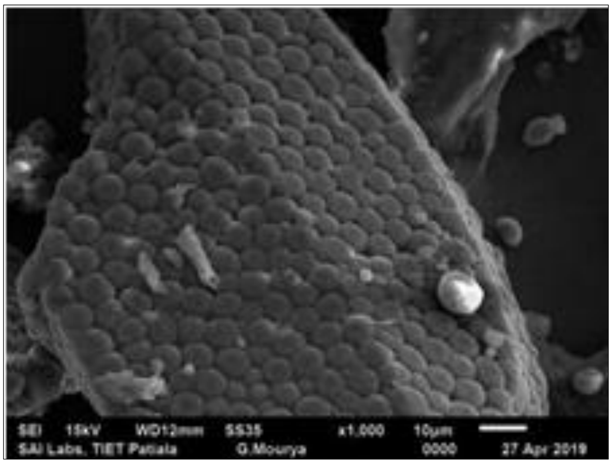
3.2.3 Porosity
Porosity is a factor dependent on size, shape and boldness of seeds. It must be noted that porosity of the mass of seeds determines the resistance to airflow during aeration and drying procedures. It must be noted that porosity of the mass of seeds determines the resistance to airflow during aeration and drying procedures. Maximum increase in porosity was noticed in buckwheat (44.62%), followed by ricebean (43.58%) and minimum in amaranth (28.67%). Similar results were observed by Beniwal *et al.* (2019) who concluded porosity in amaranth grains as 26.2%.

3.2.4 Water and Oil Absorption
The values of water absorption of different crops varied significantl highest values were recorded in ricebean (2.07 g/ml), followed by buckwheat (2.5 g/ml) and was lowest in amaranth (1.9 g/ml) as indicated in table 4.8. Data in table 4.8 indicates the values of oil absorption which varied significantly in amaranth (3.4 g/ml), buckwheat (2.6 g/ml), ricebean (2.4 g/ml) respectively.

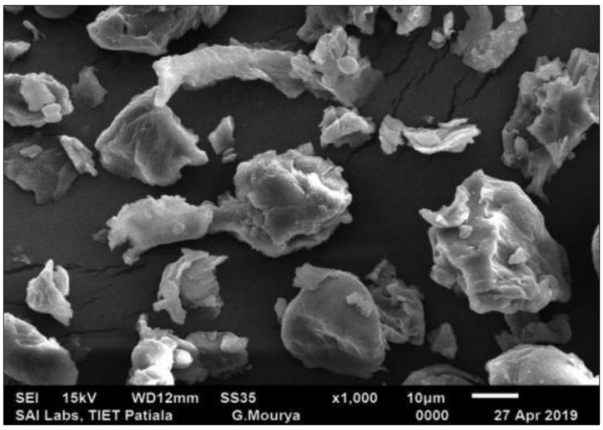
3.3 Scanning electron microscopy
Different sizes, shapes, and structures were observed for flour and ingredient powder morphology and ultra- structure using scanning electron microscopy (SEM) analysis (Figure 1). All samples presented the same sized granules (1–1.20 µm) among all samples. This embryo-rich fraction is rich in protein, fibre, and fat which suggests that the starch granules are embedded in a matrix formed by these compounds. Li and Zhu observed that some starch aggregates appeared to be coated with a film-like substance surrounded by a protein matrix. Amaranth samples, showed circular granules with a size of 10 µm. Amaranth seed is one of the few sources of small-granule starch, typically 5-10 µm in diameter, with a regular granule size. The starch granules in amarath also appeared to be embedded within a matrix. Buckwheat starch granules showed the size (10 µm) among the pseudocereal samples with a mixture of spherical and polygonal structures. Christa *et al*. also observed spherical, oval, and polygonal granules with a size distribution from 2 to 8 µm for buckwheat starch. Analysis of the granule structure and matrix positioning showed other components attached which may be protein and fat. Analysis of ricebea ultrastructure showed starch granules with diameter between 10 µm, with an angular shape. These results are in agreement with Nienke *et al*. who categorized starch granules into different sizes and defined the starch granules for amaranth and quinoa as very small, rice and buckwheat as small granules. The small size of the starch granules of some pseudocereals, such as quinoa, can offer advantages (e.g., altered emulsion stabilisation properties) in respect of incorporation into product formulations.



Amaranth



Buckwheat



Ricebean

Fig 1: Images of SEM of amaranth, buckwheat ad ricebean

Conclusion
From the results it can be concluded that the acceptable quality of value added products can be prepared from amaranth, buckwheat and ricebean. The addition of under-utilized crops in food products will improve their nutritional and functional properties. The addition of ricebean and amaranth improved protein content along with other nutrients. Utilization of the under-utilized crops in value added products

will not only help the consumer to harness the nutritional and medicinal benefits of the under-utilized crops but will also suggest ways for their utilization.

References

1. Akubugwo, Obasi GC, Chinyere, Ugbogu AE. Nutritional and chemical value of Amaranthus hybridus, leaves from Afikpo, Nigeria. African Journal of Biotechnology. 2007; 6(24):2833-2839
2. AOAC. Approved methods of association of Official Analytical Chemists. 7th Edition, Saint Paul, Minnesotea, 2000, 345p.
3. Awasthi CP, Thakur M, Dua RP, Dhaliwal YS. Biochemical evaluation of some promising varities/genotypes of ricebean. Indian Journal of Agricultural Biochemistry. 2011; 24(1):39-42.
4. Baik, Klamczynska, Czuchajowska. Particle Size of Unsweetened Azuki Paste as related to cultivar and cooking time. Journal of Food Science. 1998; 63(2).
5. Bajaj. Nutrients and anti-nutrients in ricebean varieties as effected by soaking and pressure cooking. Asian Journal of Diary and Food Research. 2013; 33(1):71-74.
6. Bressani R, Ruiz AS. Effect of germination on the chemical composition and nutritive value of amaranth grain. Journal of Cereal Chemistry. 1987; 67(6):519-522.
7. Charanjeet KH, Jasbir KK, Gupta N, Kochhar A. Cooking quality and nutritional evaluation of ricebean (*Vigna umbelleta)*. Journal of Food Science and Technology. 1987; 25:133-136.
8. Deosthale YG. Nutritive value of a less familiar Cereal-*Cheniopodium album.* The Indian Journal of Nutrition and Dietetics. 1981; 18(2):92-96.
9. Emire, Arega. Value added product development and quality characterization of amaranth grown in East Africa. African Journal of Food Science and Technology. 2012; 3(6):129-141.
10. Jain, Hauptti H. Grain amaranth, A new crop of California Agronomy Proress Report 107, Agriculture Experiment Station, University of California, Davis, 1980.
11. Joshi KD, Bhandari B, Gautam R, Bajracharaya J, Hollington PA. Ricebean: a multipurpose underutilized legume. Paper presented at the 5th International Symposium on New Crops and uses: their role in a rapidly changing world. The University of Southampton, Southampton, UK. 2007; 3-4:6p.
12. Kaur M, Kawatra BL. Effect of domestic processing on flatus producing factors in ricebean (*Vigna umbellate)*. Nahrung. 2000; 44:447-450.
13. Milovanovic, Demin V, Radovic Zarkovic, Stikic. Evaluation of the nutritional quality of the wheat bread prepared with Quinoa, Buckwheat and Pumpkin seed blends. Journal of Agricultural Sciences. 2014; 59(3):319-328.
14. NIN. A manual of laboratory techniques, National Institute of Nutrition, Hyderabad, 1983.
15. Padulosi S, Hodgkin T, Williams JT, Haq N. Underutilized crops: Trends, challenges and opportunities in the 21st century. in Engels, J. M. M., Rao, V. R., Brown, A. H. D. and Jackson, M. T., (eds.) Managing Plant Genetic Diversity, 2002, 323-338.
16. Partap, Kapoor P. The Himalyan grain Chenopod I. Comparative morphology, Agriculture Ecosystem and Environment. 1985a; 14(3-4):185-199.
17. Partap, Kapoor P. The Himalyan grain Chenopod II. Comparative morphology, Agriculture Ecosystem and Environment. 1985b; 14(3-4):201-220.
18. Petras, Kraujali. Nutritional components of amaranth seeds and vegetables: A Review on properties, composition and uses. Comprehensive reviews in Food Science and Food Safety. 2013; 12(4):381-412.
19. Piper CS. Methods for the ashing of plant materials (Chapter II). In: Soil and Plant Analysis, Hans Publishers, Nicol Road, Bombay, 1966, 258-275.
20. Rangana S. Handbook of analysis and quality control for fruits and vegetableproducts. 3rd Edition, Tata McGraw-Hill Publishing Company Limited, New Delhi, 1995, 39p.
21. Ren SC, Liu ZL, Wang P. Proximate composition and flavonoids content and *in vitro* antioxidant activity of ten varities of legume seeds grown in China. Journal of Medicinal Plants Research. 2012; 6:301-308.
22. Saharan K, Khetarpaul N, Bishnoi S. Antinutrients and protein digestibility of fababean and ricebean as affectd by soaking, dehulling and germination. Journal of Food Science and Technology. 2002; 39(4):418-422.
23. Shweta. Study on the biochemical profile of five different *Vigna* species prevalent under mid hill condition of Himachal Pradesh. Ph.D. Thesis. CSKHPKV, Palampur, 2013.
24. Srivastava RP, Srivastava GK, Gupta RK. Nutritional quality of pulses. Indian Journal of Agricultural Biochemistry. 2003; 16:57-65.
25. Swaminathan M. Processed supplementary foods and novel foods In: Food Science and Experimental foods. The Bangalore Printing and Publishing Co. Ltd., USDA SR23. 2010. Nutritional data on the SkipThePie.org, 1987, 349-356.
26. Valencia-Chamorro SA. Quinoa. In: Cabal- Iero B. Encyclopedia of Food Science and Nutrition, Academic Press, Amsterdam, 2003, 4895-4902.
27. Verma P, Mehta U. Study of the characteristics, sensory evaluation and the effect of sprouting, cooking and dehulling on the antinutritional factors of ricebean (*Vigna umbellate)*. Journal of Food Science and Technology. 1988; 25(4):197-200.