Journal of Pharmacognosy and Phytochemistry
Available online at www.phytojournal.com

E-ISSN: 2278-4136
P-ISSN: 2349-8234
JPP 2019; SP5: 11-16

A Anand
Department of Food Science, Nutrition and Technology CSK-Himachal Pradesh Agricultural University, Palampur, Himachal Pradesh, India

YS Dhaliwal
Department of Food Science, Nutrition and Technology CSK-Himachal Pradesh Agricultural University, Palampur, Himachal Pradesh, India

R Verma
Department of Food Science, Nutrition and Technology CSK-Himachal Pradesh Agricultural University, Palampur, Himachal Pradesh, India

Correspondence
A Anand
Department of Food Science, Nutrition and Technology CSK-Himachal Pradesh Agricultural University, Palampur, Himachal Pradesh, India

(Special Issue- 5)
International Conference on
"Food Security through Agriculture & Allied Sciences"
(May 27-29, 2019)

Formulation and quality evaluation of weaning food mixes supplemented with dehydrated apple based on under-utilized crops of Himachal Pradesh

A Anand, YS Dhaliwal and R Verma

Abstract
Most of the requirement of weaning foods is being met through commercially produced weaning foods prepared by various processes which are either complicated or too expensive Therefore, an attempt was made to develop less costly but nutritionally excellent weaning products. The study was undertaken with the objective to formulate and evaluate nutritional characteristics of weaning food mixes prepared from blends contained underutilized crops and further enriched with dehydrated apple. So various formulations of weaning food mixes with different proportion of flour of under-utilized crops viz. amaranth, buckwheat, rice bean and adzuki bean were used which were further supplemented with 10 percent dried apple and 15 percent of skimmed milk powder and 15 percent of sugar each. The study revealed that the supplemented weaning food mixes are economical, have better functional properties, improved nutritional profile with acceptable sensory properties. Different formulations have been standardized using different proportions of amaranth, buckwheat and adzuki bean in different ratios. These mixes were rich in protein, fibre and contained good amount of vitamin-C. The iron, copper, manganese and zinc contents also improved with supplementation of dehydrated apple. The sensory evaluation on nine point hedonic scale revealed that apple supplemented weaning food mixes were highly acceptable for colour, flavor, texture, taste and overall acceptability when tasted by trained group of panels.

Keywords: Nutritional characteristics, weaning food mixes, underutilized crops, formulations, dehydrated apple

1. Introduction
Underutilized or neglected crops species are often indigenous ancient crop species which are still used at some level within the local, national or even international communities, but have the potential to contribute further to the mix of food sources than they currently do (Mayes *et al*., 2011) [9]. Global food security has become increasingly dependent on only handful of crops and underutilized and neglected species fall within the broad basket of "minor crops". The use of two terms *viz.* underutilized and neglected crops have an advantage to pinpoint two crucial aspects which are at the core of these species, *viz.* the degree of attention paid by users and the level of research and conservation efforts spent on them. Underutilized plant species have a distinctive past, current, or potential use value, but their use is currently limited relative to their economic potential (Gruere *et al*., 2006).
Underutilized crops also referred by other terms such as underexploited, underdeveloped, lost new, novel, promising, alternative, local and traditional crops. Many neglected and underutilized crop species (NUCS) are nutritionally rich therefore, their erosion can have immediate consequences on the nutritional status and food security of the poor and their enhanced use can bring about better nutrition and fight hidden hunger. The underutilized foods can be defined as "the foods which are less available, less utilized or rarely used or region specific" (William and Haq, 2002) [21].
The underutilized plant 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 Uttar Pradesh. 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, horse gram, rice bean black cumin and finger millet have recently gained the attention as supplementary food crops. These crops have poor shelf-life, un-recognized nutritional value, poor consumer awareness and reputational problems, therefore, also called as, "poor people's food". As the demand for food changes, under-utilized crops can overcome the constraints to the wider production and use by the poor people. As a matter of fact, many formerly neglected crops are now globally significant crops (oilpalm, soybean, kiwi fruit) and have shown the potential to contribute to food security, nutrition, dietary and culinary diversification, health and income generation (Hammer *et al*., 2001) [6].

So these crops have great potential to play number of roles in improvement of food security and to utilize these species having comparative advantages in providing better food affordable by poor. Buckwheat, amaranth, chenopodium, 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 consumer's acceptability of the formulated weaning food mixes for the product development.

The word "wean" is derived from Anglo-Saxon "*wenian"* meaning "to accustom" (as a child) to take food otherwise than by nursing. The main concern is making sure that there is no gap between nutrient requirements and what a child is able to consume, absorb and utilize. Nutritional status in children is most vulnerable during the weaning stages when both macro and micro nutrients may be insufficient to maintain growth and development.

Weaning is a transition period when the diet changes from complete breast feeding (up to 4-6 months) to when the child is able to eat normal family food (around one year).Most of the requirement of weaning foods is being met through commercially produced weaning foods prepared by various processes which are either complicated or too expensive as spray drying and extrusion cooking. Weaning foods, thus prepared are excellent and meet the maximum requirements of the infant. However, these marked products are too expensive for the majority of population in developing countries who need such a product in developing countries. Therefore, it is need of the society to develop ways and means of developing less costly but nutritionally excellent products within the reach of wider population. The basic bulk raw materials should be locally available staple grains. The process or technology of production should not be sophisticated and it should be highly adaptable.

The weaning food formulations should be nutritionally well-balanced in terms of proteins, fat, energy and essential vitamins and minerals. The fibre content should be low or within the permitted limits. It should be pre-cooked or instant so that it can be fed to babies as a soft product by simple stirring in hot or boiling water and should be safe and also have good storage stability. Keeping the significance of these under-utilized crops in interest, the formulation and development of nutritious weaning foods from these crops has received a lot of attention, as well as stimulating interest.

The locally available agricultural produce as amaranth, buckwheat, rice bean and adzuki bean are not costly, and the simple, traditional processing technique can be used to develop easily prepared/available, nutritious tastier, safer and cost effective weaning food mixes.

Among these crops amaranth grain has high protein, as well as a high fat content and has the potential to use it as an energy food. The balance of carbohydrates, fats, and protein, allow amaranth the opportunity to achieve a balanced nutrient uptake with lower amounts of consumption than with other cereals. The amaranth grain is also high in minerals such as calcium, potassium, phosphorus, as well as dietary fibre. Rice bean [*Vignaum bellata*] is also known as climbing mountain bean, mambi bean, oriental bean and red bean. Rice bean is one of best legume, rich in protein (21-25%) and amino acid profile, especially the more limiting amino acids namely, methionine and tryptophan and considerably high quality of vitamins as well as minerals. Buckwheat (*Fagopyrumes culentum*) is a valuable source of proteins, fibers, and minerals, such as iron, manganese and selenium. Some buckwheat components, such as proteins possess valuable cholesterol lowering properties and remarkable outstanding health promoting properties (Christa and Soral-Smentana, 2008). Adzuki bean (*Vigna angularis)* is grown throughout East Asia and the Himalyas. The name adzuki comes from Japanese languages, which are red in colour and found in certain areas. These are high in dietary fiber, and rich in folate, potassium and magnesium. Dry adzuki bean are high in protein but still it is considered as an under-utilized crop.

2. Material and Methods

The investigation entitled "Formulation and quality evaluation of weaning food mixes supplemented with dehydrated apple based on under-utilized crops of Himachal Pradesh" was conducted in the Department of Food Science, Nutrition and Technology, College of Home Science, CSK Himachal Pradesh Krishi Vishvavidyalaya, Palampur during the year 2014-2016.

Four under-utilized crops Rice bean, Adzuki bean, Buckwheat and Amaranth were procured from Department of Organic Agriculture, CSKHPKV, Palampur Regional Research Station, Sangla and from market. The apple required in the study were also procured from the local market.

2.1 Preparation of samples

The procured seed samples were cleaned manually to remove adhering dirt, dust and foreign particles. Then the seeds were ground in to a fine powder with the help of stainless steel mixer and stored in airtight containers so as to prevent changes till further analysis. Four treatments were given to them by following methods:

The roasting of buckwheat was carried out by dropping the seeds in a preheated cauldron and pressing and moving with the help of moulded cloth. The seeds of rice bean and adzuki bean were steeped in potable tap water for 12hrs and grain to water ratio (1: 3) was such as to dip the seeds completely. The seeds of amaranth were popped by dropping the seeds in a pre-heated cauldron and moving with help of moulded cloth until the seeds were white in colour.

The procured samples of apple were then cleaned manually to remove adhering dirt, dust and foreign particles. Then the fruit were cleaned and washed properly. Peeling of apple was done and then it was dipped in KMS solution for half an hour. Further, these apples were dried at 67 ^{o}C and was made into fine powder with the help of stainless steel mixer and stored in airtight containers so as to prevent changes till further analysis.

2.2 Nutritional characteristics of samples

Proximate parameters were analyzed by using standard methods (AOAC 2010) [2]. The observations were made in triplicate to reduce the errors. β carotene and ascorbic acid was observed by the method of Rangana, 1995 [13]. Amino acids such as tryptophan (Spies and Chambers, 1949) [14] and methionine (Horn *et al*., 1946) [8] were also analysed. Mineral content was observed by the method of Piper 1966 [12].

3. Results and Discussion

3.1 Nutritional composition of Weaning Food Mixes (Amaranth: Buckwheat: Rice bean: Adzuki bean) supplemented with Apple

The nutritional values of the weaning food mixes prepared from amaranth, buckwheat, rice bean and adzuki bean supplemented with apple tested ranged as follows: moisture, 8.45-10.1%; crude protein, (15.76-16.89%); crude fat, (4.12-6.48%); crude fibre, (2.45-5.82%), total ash (2.34-3.21%); total sugars, (4.94-5.78 g/100g); ascorbic acid, (2.89-3.89 mg/100g); β-carotene, (0-12.79 µg/100g); methionine, (0.06-0.022 g/100g); tryptophan, 90.47-0.66 g/100g; phytic acid, 288-314 mg/100g and saponins;1.28-1.85 g/100g.

Data in Table 2 indicates the moisture content in weaning food mixes varied significantly and maximum was observed in WFM 02 (10.1%), followed by WFM 04 (8.54%) and least in WFM 03 (8.13%). The protein content varied highly significantly in WFM 01(16.89%), followed by WFM 04 (15.91%), WFM 02 (15.89%) and WFM 03 (15.76%). However the protein values of 'WFM 04', 'WFM 02' varied critically non-significant. The values of crude fat varied significantly and were highest in WFM 02 (6.48%) followed by WFM 01 (6.46%) and lowest in WFM 03 (5.35%). Similar results were observed by Verma *et al*. (2009) [19] in rice bean for preparation of biscuits and results revealed fat and protein contents of the biscuits ranged between 6.03 to 6.53 and 13.27 to13.33 per cent respectively. 'WFM 04' and 'WFM 02' varied critically non-significant.

The values of crude fibre varied significantly in WFM 03 (5.82%), followed by WFM 04 (5.52%), WFM 02 (5.21%) and WFM 01 (2.45%). Table 2 indicates the total sugars of different WFM which varied significantly in WFM 03 (5.78 g/100g), followed by WFM 02 (5.5g /100 g) and lowest in WFM 04 (4.94 g/100 g). However the total sugars in 'WFM 02' and 'WFM 03' were varied critically non-significant. Ascorbic acid content varied significantly in WFM 01 (2.89 mg/100 g), WFM 02 (3.89 mg/100 g), WFM 03 (3.21 mg/100 g) and WFM 04 (3.11 mg/100 g). The values of β-Carotene were observed highly significant in WFM 04 (12.79 µg/100 g), followed by WFM 03 (10.89 µg/100g) and no β-Carotene content was observed in WFM 02.

The values of phytic acid were found to be highest in WFM 02 (314 mg/100g) followed by WFM 03 (298 mg/100g) and lowest in WFM 04 (288 mg/100g). However the values of phytic acid varied critically non-significant in 'WFM 04' and 'WFM 01'. The saponin content was recorded highly significant in WFM 03 (1.85 g/100gm) and lowest in WFM 04 (1.28 g/100gm).

The values pertaining to mineral content are given in table 3. The results for mineral content varied significantly with each other. The values of calcium were found to be highest in WFM 03 followed by WFM 04 and lowest in WFM 02. However 'WFM 01' and 'WFM 03' in copper, 'WFM 02' and 'WFM 04' in manganese and 'WFM 01' and 'WFM 03' in zinc varied critically non-significant.

3.2 Organoleptic characteristics of selected Weaning Food Mixes using nine point hedonic scale

Selected weaning food mixes supplemented with apple WFM 03 and WFM 04 were varied critically non-significant in colour. These mixes were highly significant in flavor and taste. However WFM 01, WFM 03 and WFM 04 were varied critically non-significant in flavor and all mixes were varied critically non-significant in taste. In overall acceptability mixes were varied significantly. However, WFM 01 and WFM 04 were varied critically non-significant. WFM 02 was most acceptable due to its good colour, flavor, texture and overall acceptability. Similarly, Dhaliwal *et al.* (2011) [4] standardized the recipes based on buckwheat, rice bean and amaranthus. Buckwheat, rice bean and amaranthus flours were used in different proportions for preparation of supplemented foods and prepared products were evaluated for sensory acceptability by panel of judges.

Table 1: Formulations used for preparation of weaning food mixes contained following ingredients

Sample no.	Amaranth	Buckwheat	Rice bean	Adzuki Bean	Apple	Skimmed milk powder	Sugar
1	60	0	0	0	10	20	15
2	45	15	0	0	10	20	15
3	30	30	0	0	10	20	15
4	45	0	15	0	10	20	15
5	30	0	30	0	10	20	15
6	30	15	15	0	10	20	15
7	45	0	0	15	10	20	15
8	30	0	0	30	10	20	15
9	30	15	0	15	10	20	15

Table 2: Nutritional composition of Weaning Food Mixes (Amaranth: Buckwheat: Rice bean: Adzuki bean) supplemented with Apple

Parameters	WFM 01 (60:0:0:0:10)	WFM 02 (45:15:0:0:10)	WFM 03 (30:15:15:0:10)	WFM 04 (30:15:0:5:10)	CD ($P \leq 0.05$)
Moisture (%)	8.45	10.1	8.13	8.54	0.04
Crude Protein (%)	16.89	15.89	15.76	15.91	0.05
Crude Fat (%)	6.46	6.48	5.35	4.12	0.04
Crude Fibre (%)	2.45	5.21	5.82	5.52	0.05
Total Ash (%)	2.34	2.98	3.12	3.21	0.05
Total Sugars (g/100gm)	5.21	5.5	5.78	4.94	0.28
Vitamin-C (mg/100gm)	2.89	3.89	3.21	3.11	0.04
B-carotene (µg/100gm)	1.09	0	10.89	12.79	0.04
Phytic acid (mg/100gm)	289	314	298	288	5.21
Saponins (g/100gm)	1.32	1.76	1.85	1.28	NS

*(Ratio: Amaranth: Buckwheat: Rice bean: Adzuki bean: Apple)

Table 3: Mineral content of Weaning Food Mixes (Amaranth: Buckwheat: Rice bean: Adzuki bean) supplemented with Apple

Parameters	WFM 01 (60:0:0:0:10)	WFM 02 (45:15:0:0:10)	WFM 03 (30:15:15:0:10)	WFM 04 (30:15:0:5:10)	CD (*P*≤0.05)
Calcium (mg/100g)	132.7	121.5	201.5	177.7	9.24
Phosphorus (mg/100gm)	256.6	272.6	295.4	295.3	3.88
Magnesium (mg/100gm)	204.3	174.4	121.4	89.42	3.73
Iron (mg/100gm)	7.12	2.30	1.44	0.91	0.19
Copper (mg/100gm)	1.05	1.02	1.12	1.17	0.07
Manganese (mg/100gm)	0.91	0.79	0.88	0.71	0.04
Zinc (mg/100gm)	1.12	0.51	1.05	0.79	0.04

*(Ratio: Amaranth: Buckwheat: Rice bean: Adzuki bean: Apple)

Fig 1: Amino acid content (gm/100 gm) of Weaning Food Mixes (Amaranth: Buckwheat: Ricebean: Adzuki bean)supplemented with Apple

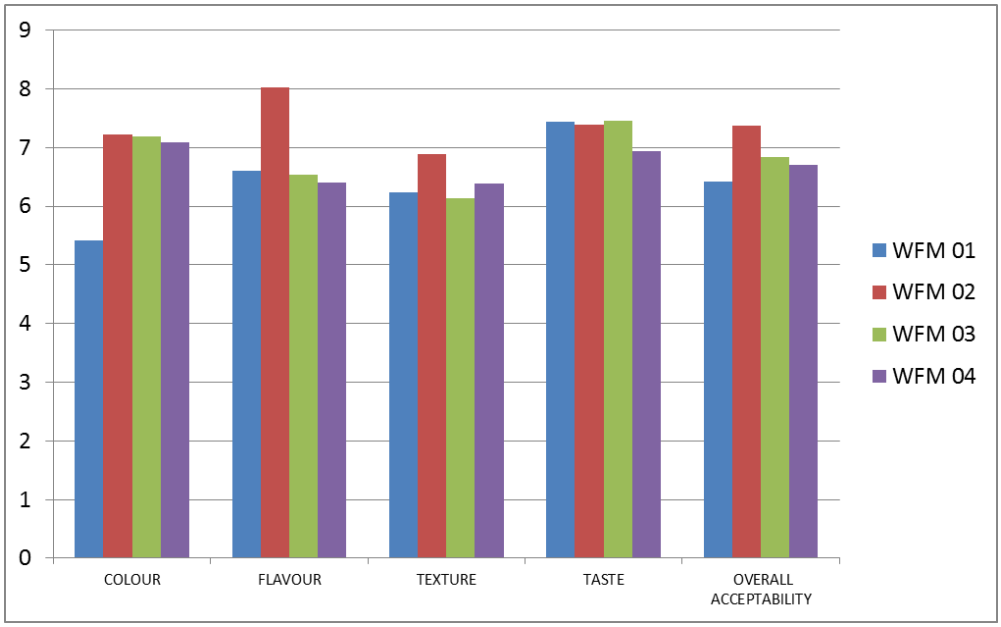

Fig 2: Organoleptic acceptability of Weaning Food Mixes prepared from formulation (Amaranth: Buckwheat: Rice bean: Adzuki bean) supplemented with apple

Plate 1: Under-utilized crops used in preparation of weaning food mixes

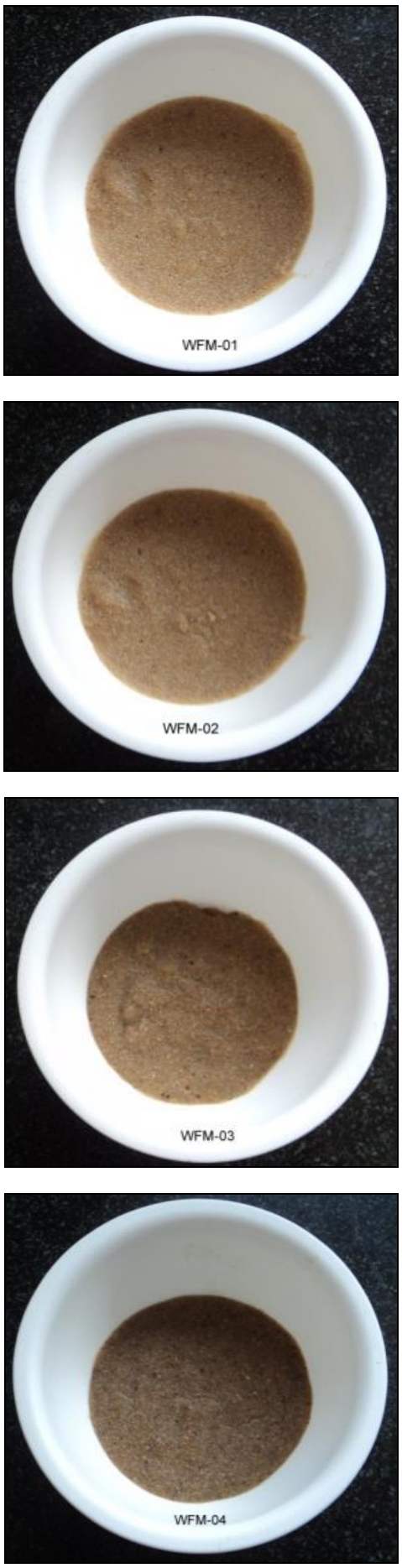

Plate 2: Weaning food mixes prepared from formulation (Amaranth: Buckwheat: Ricebean: Adzuki bean) supplemented with apple

4. Conclusion

From the results it can be concluded that the acceptable quality of weaning food mixes can be prepared from amaranth, buckwheat, rice bean and adzuki bean. The addition of under-utilized crops in weaning food mixes improved nutritional and functional properties. The addition of rice bean and adzuki bean improved protein content along with other nutrients. The sensory scores of all the parameters in apple supplemented weaning food mixes were highly acceptable. Further utilization of the under-utilized crops in weaning food mixes 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.

5. References

1. Anand Malhotra. Formulations of weaning food mixes. Asian Journal of Dairy and Food Research. 2010; 29(2):136-139.
2. AOAC. Approved methods of association of Official Analytical Chemists. 7th Edition, Saint Paul, Minnesotea, 2010, 345.
3. Dansi A, Vodouhè R, Azokpota P, Yedomonhan H, Assogba P, Adjatin A *et al*. Diversity of the Neglected and Underutilized Crop Species of Importance in Benin. The Scientific World Journal, 2011, 20(11).
4. Dhaliwal YS, Verma R, Mittal RKBhandari DC. Buckwheat, rice bean and amaranthus-value added products. Booklet published under AICRN project on underutilized crops, 2011.
5. Gruere GP, Nagarajan L, King EDI Oliver. Collective action and marketing of underutilized plant species. International Food Policy Research Institute (IFPRI), 2007.
6. Hammer K, Heller J, Engels J. Monographs on underutilized and neglected crops. Genetic Resources & Crop Evolution. 2001; 48(1):3-5.
7. Hedge JE, Horfreiter BT. In: Carbohydrates Chemistry, 17, (eds. Whistler RL, BeMiller JN.) Academic Press, New York, 1962.
8. Horn MJ, Jone DD, Blum AE. Colorimetric determination of methionine in proteins and foods. Journal of Biological chemistry. 1946; 116(1):313-320.
9. Mayes S, Massawe PG, Alderson JA, Roberts SN, Azam Ali, Hermann M. The potential for underutilized crops to improve security of food production. Journal of Experimental Botany, 2011, 1-5.
10. NIN. A manual of laboratory techniques, National Institute of Nutrition, Hyderabad, 1983.
11. Paula HDE, Santos RC, Silva ME, Gloria ECS, Pedrosa ML, Almeida NAV *et al*. Biological evaluation of nutritional supplement prepared with QPM maize cultivar BR-473 and other traditional food items. Brazialian Archines of Biology and Technology. 2004; 47(2):247-251.
12. Piper CS. Methods for the ashing of plant materials (Chapter II). In: Soil and Plant Analysis, Hans Publishers, Nicol Road, Bombay, 1966, 258-275.
13. Rangana S. Handbook of analysis and quality control for fruits and vegetable products. 3rd Edition, Tata McGraw-Hill Publishing Company Limited, New Delhi, 1995, 39.
14. Spies JR, Chamber DC. Chemical determination of tryptophan in protein. Analytical Chemistry. 1949; 21(10):1249-1266.

15. Srivastava RP, Srivastava GK, Gupta RK. Nutritional quality of pulses. Indian Journal of Agricultural Biochemistry. 2003; 16:57-65.
16. Swaminathan M. Processed supplementary foods and novel foods In: Food Science and Experimental foods, 1987, 349-356.
17. Thakur M. Underutilized food crops: treasure for future India. Food science and Research Journal. 2014; 5(2):174-183.
18. USDA SR23. Nutritional data on the Skip the Pie. Org, 2013.
19. Verma P, Mehta U. Study of the characteristics, sensory evaluation and the effect of sprouting, cooking and dehulling on the anti-nutritional factors of rice bean (Vigna umbellate). Journal of Food Science and Technology. 2009; 25(4):197-200.
20. WHO. Weaning from breast milk to family food. A guide for health and community workers, 1988, 3-5.
21. Williams JT, Haq N. Global research on underutilized crops-an assessment of current activities and proposals for enhanced cooperation. International Centre for Underutilized Crops, 2002. ISBN 92-9043-545-3