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Development of amaranth grain (*Amaranthus cruentus*) based instant Dosa mix and its quality characteristics

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Abstract
Introduction: The demand for traditional Indian foods is increasing and people have developed a flair for the tastes of South Indian dishes like dosas, idlis, and uttappams. The food industry has made it easy to have access to these varied tastes of India through the Ready-to Cook or Ready-to Eat foods. This research was carried out to utilize gluten free, nutritious and low cost amaranth grains along with bengal gram dal and vegetables to produce a convenience food that can be consumed by celiac patients in India.
Methodology: The amaranth grain was subjected to dry roasting and germination and made into flour. The pre-treated amaranth grain flour (dry roasted and germinated) and bengal gram dal flour was combined in the ratio of 1:1. Untreated amaranth grain flour used in the dosa mix was considered as control. The experimental dosa mixes were subjected to nutrient and sensory analysis. The functional properties of the flour reflect on its cooking characteristics and quality of the final product and hence they were analysed.
Results: There was a significant difference in the proximate composition and functional properties of the experimental dosa mixes. Sensory analysis revealed that all the samples ranked similar for all the attributes. The study recommends germination of amaranth grains for its better nutritive value and its utilisation in the preparation of the traditional recipe-dosa.

Keywords: amaranth grain (*Amaranthus cruentus*), bengal gram (*cicerarietinum*), pseudo cereal, celiac disease, germination, dryroasting

1. Introduction

Cereal/legume-based foods are a major source of economical dietary energy and nutrients worldwide**.** With the changes in life style, consumers do not prefer meals that requires a long preparation time. There is a large demand for convenience foods. The activities of cleaning, grinding, mixing, blending and cooking are bypassed by the consumers; instead they look for foods with less preparation time. The preference of convenience food is due to the importance of time.

Dosa is a traditional food that is largely consumed in India, largely by Southern India. It is a fermented product made from finely ground wet milled rice and dehulled black gram. It is a fermented product which is fried as a thin, crispy pancake and consumed with chutney and/or sambar. There arealso other types of traditional dosa which does not require fermentation like wheat dosa, ragi dosa, etc.

The current study aimed to formulate a ready to cook Instant dosa mix with Amaranth and Bengal gram flour. The objective of the study is also to understand the impact of pretreatments- dry roasting and germination on the nutritional and functional properties of the dosa mix.

Amaranth grain is a pseudocereal which has better nutritional profile than the traditional cereals which is also gluten-free. In India, amaranth is known as Rajgira. Amaranth grains were a staple food of the Inca and the Aztec civilizations for thousands of years. Amaranth was also considered major crop used by the Pre-Colombian cultures in Latin-America for centuries, as important as maize and beans. (Berghofer *et al,* 2002; Mota *et al,* 2016) [5, 12]. Amaranth grains share characteristics of both a cereal and a leguminous seed from botanical and nutrient composition point of view as the protein content and the amino acid composition of these grains are somewhere between those of a cereal and a legume. Therefore, it could be considered as a natural mixture of rice and beans nutritionally (Caselato-Sousa *et al.*) [6]. Cereals are considered "unbalanced" in terms of amino acid composition because they possess very low amounts of lysine for optimum health. Amaranth protein has nearly twice the lysine content of wheat protein and thrice the content of maize protein. It contains lysine almost as much as is found in milk which is considered the standard of nutritional excellence (A.C.T.I. 1984) [1]. Amaranth also has high vitamin and mineral contents, such as riboflavin, niacin, ascorbic acid, calcium and magnesium and a low level of anti-nutritional factors (Zapotoczny *et al,* 2006) [20]. Bengal gram (*Cicerarietinum*) is a legume that belongs to the family Fabaceae. Bengal gram has formed a staple diet of the poor for generations in India. Bengal gram is legume grown in tropical and subtropical regions which has a high potential as a functional ingredient in food industry.

Amaranth grain being gluten free, this dosa mix would be a good hope for celiac patients.

2. Materials and Methods

Amaranth grains and all the ingredients required for making cookies were procured from local supermarket

2.1 Preparation of amaranth grain flour

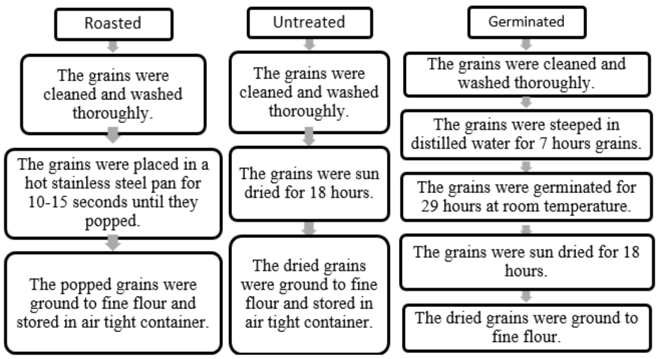

Fig 1: Preparation of amaranth grain flour

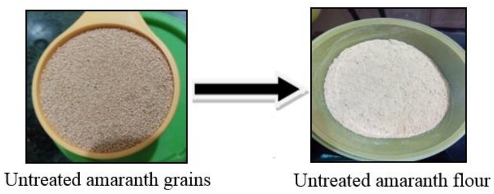

Fig 2: Preparation of untreated amaranth grain flour

Fig 3: Preparation of germinated amaranth grain flour

Fig 4: Preparation of dry roasted amaranth grain flour

2.2 Preparation of taste maker

The taste maker consists of dried carrots, dried onion, dried fenugreek leaves, red chilli powder, roasted cumin seed powder and salt. The carrots and onions were shredded and dried using convection oven at 180º C for 70 minutes. The dried fenugreek leaves and roasted cumin seeds were ground to powder separately. Other ingredients does not require pre-treatment. All the ingredients were mixed together in the proportion given in table 1. The net weight of taste maker is 65 grams.

2.3 Preparation of Experimental Instant Dosa mix

The experimental dosa mix and the taste maker were packaged separately in their primary packages and then packaged together in a secondary package. The package consists of 435 grams of dosa mix and 65grams of taste maker. The experimental dosa mix consists of processed amaranth grain flour and Bengal gram dal flour in the ratio of 1:1. The composition of the experimental instant dosa mix is mentioned in table 2. The three experimental instant dosa mixes were prepared using untreated, dry roasted and germinated amaranth grain flour namely UTDM, DRDM and GDM. 500ml, 600ml and 425ml of water is required to prepare batters from UTDM, DRDM and GDM respectively. It is due to the different water absorption capacity of each type of flour. The batter should have a consistency similar to pan cake batter. A ladle of batter was poured and spread on a greased non-stick pan and cooked. 500grams of dosa mix can produce 20-25 medium sized dosa.

Table 1: Codes assigned for various samples

Codes	Abbreviations
UTDM	Untreated amaranth grain flour instant Dosa Mix
DRDM	Dry Roasted amaranth grain flour instant Dosa Mix
GDM	Germinated amaranth grain flour instant Dosa Mix

Table 2: Composition of experimental instant dosa mixes

Ingredients	UTDM	DRDM	GDM
Flour (435g)			
Amaranth flour	217.5g	217.5g	217.5g
Bengal gram dal flour	217.5g	217.5g	217.5g
Taste maker (65g)			
Carrot powder	20g	20g	20g
Onion powder	20g	20g	20g
Dried Fenugreek leaves powder	10g	10g	10g
Red chilli powder	5g	5g	5g
Turmeric powder	2.5g	2.5g	2.5g
Roasted cumin seed powder	2.5g	2.5g	2.5g
Salt	5g	5g	5g

Net weight: 500g

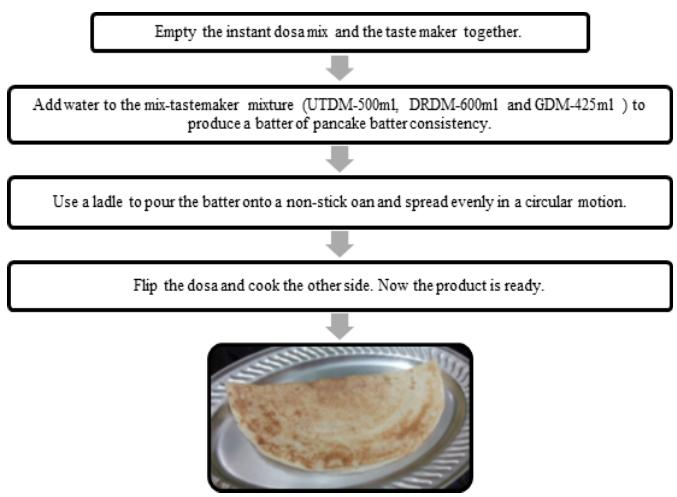

Fig 5: Preparation of experimental dosa

2.4 Experimental Analysis

The following tests were carried out using standard procedures.

2.4.1 Proximate composition

Moisture, Ash, Crude Fibre, Protein, Iron, Calcium and Fat

(AOAC 2000) [3], Total carbohydrates (FAO 2003) [10], Total Calorie(James 1995) [11].

2.4.2 Functional properties

Bulk Density, Water Absorption, Oil Absorption, Swelling Power, Foam Capacity, Emulsion Stability (AOAC 2006) [2].

2.4.3 Sensory analysis

Sensory evaluation was carried out for all the 3 variations of dosa on a 9 – point hedonic scale rating by 15 semi- trained panellists. Each panellist was given a sensory evaluation sheet and the cookies were rated for parameters such as colour, flavour, texture, taste, crunchiness, breakability, mouth feel, after taste and overall acceptability (Peryam and Pilgrim 1957) [14].

2.4.4 Statistical analysis

All the experimental analysis was carried out in triplicates. Data were reported as mean and standard deviation. Paired t test was carried out to compare the significant difference between the untreated dosa mix and the germinated dosa mix and also between untreated and dry roasted dosa mix. One way ANOVA was carried out to validate if there was any significant difference in the nutritive value and functional properties among the three dosa mix and also to analyze any significant difference in the sensory attributes of the dosa variations. Data analysis was done using SPSS version 20.0.

3. Results and Discussion

3.1 Proximate Composition of the flour

Proximate composition such as moisture, ash, fibre, carbohydrates, calories, protein, iron calcium and fat were estimated for the experimental Dosa mixes UTDM, DRDM and GDM. The results are tabulated in table 3.

Table 3: Nutritional analysis of the experimental Dosa mixes

Test parameters / Samples	UTDM	DRDM	GDM
Moisture (%)	8.16 ± 0.11	9.06 ± 0.06* (+11.08)$^{\#}$	9.16 ± 0.13** (+12.26)$^{\#}$ (+1.13)$^{!}$
Ash (%)	9.92 ± 2.98	8.09 ± 1.56^{NS} (-18.41)$^{\#}$	16.22 ± 2.20** (+63.41)$^{\#}$ (+100.27)$^{!}$
Crude fibre (%)	3.27 ± 0.01	3.87 ± 0.02*(+18.27)$^{\#}$	3.88 ± 0.01** (+18.78)$^{\#}$ (+0.43)$^{!}$
Crude fat (%)	5.98 ± 0.02	5.68 ± 0.01* (-5.07)$^{\#}$	2.04 ± 0.01** (-65.98) $^{\#}$ (-64.16)$^{!}$
Protein (%)	16.55 ± 0.05	16 ± 0.01* (-3.28)$^{\#}$	17.62 ± 0.02** (+6.47)$^{\#}$ (+10.08)$^{!}$
Total Carbohydrate (g/100g)	106.09 ± 0.3	106.53 ± 0.05 ^{NS} (-0.42)$^{\#}$	105.99 ± 0.006 ^{NS} (-0.09)$^{\#}$ (-0.51)$^{!}$
Total calories (Kcal/100g)	355.99 ± 0.006	366.04± 0.05* (+2.82)$^{\#}$	350.06 ± 0.2** (-1.67)$^{\#}$ (-4.36)$^{!}$
Calcium (mg/100g)	83.19 ± 0.006	82.89 ±0.05* (-0.36)$^{\#}$	91.90 ± 0.005** (+10.46)$^{\#}$ (+10.86)$^{!}$
Iron (mg/100g)	3.51 ± 0.06	5.79 ± 0.008* (+65.10)$^{\#}$	7.37 ± 0.01^{2**} (+109.66)$^{\#}$ (+26.99)$^{!}$

$^{\#}$ Percentage increase or decrease between UTDM and DRDM and between UTDM and GDM.
$^{!}$percentage increase or decrease between DRDM and GDM.
*significant difference between UTDM and DRDM ($p \leq 0.05$- t-Test: Paired Two Sample for Means)
**significant difference between UTDM and GDM ($p \leq 0.05$- t-Test: Paired Two Sample for Means)
^{NS} no significant difference ($p \leq 0.05$- t-Test: Paired Two Sample for Means)

Moisture

The moisture content of UTDM, DRDM and GDM was found to be8.16 ± 0.11 %, 9.06 ± 0.06 % and 9.16 ± 0.13%. There was 11.08% and 12.26% significant ($p \leq 0.05$) increase in moisture content in the dry roasted amaranth grain dosa mix (DRDM) and germinated amaranth grain dosa mix (GDM) when compared to untreated dosa mix (UTDM) respectively. The moisture content in UTDM and DRDM were in the range of acceptable limit for shelf life stability of dry products that hinders the growth of microorganisms. But the GDM has higher moisture content which will decrease its shelf life faster.

Ash

The ash content of UTDM, DRDM and GDM was found to be9.92 ± 2.98 %, 8.09 ± 1.56 % and 16.22 ± 2.20 % respectively. There was no significant ($p \leq 0.05$) difference in the ash content between UTDM and DRDM. There was 63.41% significant ($p \leq 0.05$) increase in ash content in the germinated amaranth grain dosa mix (GDM).

Crude FIBRE

The crude fibre content of UTDM, DRDM and GDM was found to be3.27 ± 0.01 %, 3.87 ± 0.02 % and 3.88 ± 0.01% respectively. There was 18.27% and 18.78% significant ($p \leq 0.05$) increase in crude fibre content in dry roasted amaranth grain dosa mix (DRDM) and germinated amaranth grain dosa mix (GDM) respectively. There was no significant difference ($p \leq 0.05$) in the crude fibre content between DRDM and GDM. El-adawy *et al*. (2003) [9] reported a higher crude fibre content in germinated moong bean, pea and lentil seeds. A study reported higher crude fibre (5.70 g/100g) in germinated amaranth flour than raw flour (4.8 g/100g) (Chauhan 2015) [8].

Fat

The fat content of UTDM, DRDM and GDM was found to be5.98 ± 0.02 %, 5.68 ± 0.01 % and 2.04 ± 0.01 %. There was 5.07% and 65.98% significant ($p \leq 0.05$) decrease in fat content in the dry roasted amaranth grain dosa mix (DRDM) and germinated amaranth grain dosa mix (GDM) respectively.

Protein

The experimental Dosa mixes has protein content in the range of 16.55% to 17.62%. There was 3.28% significant ($p \leq 0.05$) decrease in protein content on dry roasting (DRDM). This result may be due to high temperature of roasting, being a dry heat processing method as well as prolonged time of roasting.

There was 6.47% significant (p≤0.05) increase in protein content in germinated amaranth grain dosa mix (GDM). The increase in protein content in GDM containing germinated amaranth grain flour may be due to synthesis of enzymes during germination which may have resulted in the production of some amino acids during protein synthesis (Uwaegbute, *et al.,* 2000) [19].

Total carbohydrate

The total carbohydrate content was in the range of 105- 106 g/100g respectively. There was no significant difference in the total carbohydrate content among the dosa mixes.

Total calorie

The total calories of UTDM, DRDM and GDM were found to be355.99 ± 0.01 Kcal/100g, 366 ± 0.05 Kcal/100g and 350.06 ± 0.2 Kcal/100g respectively. There was 2.82% significant (p≤0.05) increase in the total calories content in dry roasted amaranth grain dosa mix (DRDM). There was 1.67% significant (p≤0.05) decrease in total calories content in germinated amaranth grain dosa mix (GDM).

Calcium

The calcium content of UTDM, DRDM and GDM were found to be83.19 ± 0.006 mg/100g, 82.89 ± 0.05 mg/100g and 91.90 ± 0.005 mg/100g respectively. There was 0.36% significant (p≤0.05) decrease in calcium content in dry roasted amaranth grain dosa mix (DRDM) whereas there was 10.46% significant (p≤0.05) increase in calcium content in germinated amaranth grain dosa mix (GDM).

Iron

The iron content of UTDM, DRDM and GDM were found to be3.51 + 0.06 mg/100g, 5.79 + 0.008 mg/100g and 7.37 + 0.01mg/100g respectively. There was 65.10% and 109.66% significant (p≤0.05) increase in the iron content of dry roasted amaranth grain dosa mix (DRDM) and germinated amaranth grain dosa mix (GDM) respectively.

3.2 Functional properties of experimental dosa mixes

The quality of any flour based product depends on the functional properties of the flour. The functional properties of the flour reflect on its cooking characteristics and quality of the final product.

Table 4: Functional properties of the experimental Dosa mixes

Test parameters / samples	UTDM	DRDM	GDM
Bulk density (g/cm^3)	0.72±0.006	0.72±0.01^{NS}	0.71 ± 0.002^{NS} (-1.38)$^{\#}$ (-1.38)$^{!}$
Water absorption (ml/g)	1.47±0.05	1.23 ± 0.05* (-15.91)$^{\#}$	1.33±0.05** (-9.09)$^{\#}$ (-8.11)$^{!}$
Oil absorption (ml/g)	0.77±0.05	0.53 ± 0.05* (-30.44)$^{\#}$	0.43±0.05^{NS} (-43.49)$^{\#}$ (-18.75)$^{!}$
Emulsification capacity (%)	3.72±0.006	3.12±0.004* (-16.23)$^{\#}$	3.42 ± 0.006** (-8.09)$^{\#}$ (+10.71)$^{!}$
Swelling power	3.57±0.04	3.01±0.02* (-15.89)$^{\#}$	5.42 ± 0.11** (+51.71)$^{\#}$ (+80.38)$^{!}$

$^{\#}$ percentage increase or decreasebetween UTDM and DRDM and between UTDM and GDM.
$^{!}$percentage increase or decrease between DRDM and GDM.
*significant difference between UTDM and DRDMGDM (p≤0.05- t-Test: Paired Two Sample for Means)
**significant difference between UTDM and GDMGDM (p≤0.05- t-Test: Paired Two Sample for Means)
^{NS} no significant difference GDM (p≤0.05- t-Test: Paired Two Sample for Means)

Bulk density

The particle size and the density of the flour or flour blends affect the bulk density. The bulk density of the flour could be used to determine their handling requirements because it is thefunction of mass and volume(Shittu, *et al*., 2008)[18]. Lower bulk densities of any food product may facilitate better during packaging (Nagaprabha, *et al.*, 2009) [13]
The bulk density of UTDM, DRDM and GDM was found to be0.72 ± 0.01, 0.72 ± 0.01and 0.71 ± 0.01 g/cm^3 respectively. There was no significant (p≤0.05) difference in bulk density in DRDM and GDM.

Water absorption capacity

Water absorption is the ability of the flour to absorb water and swell for improved consistency in food. It is desirable in food systems to improve yield and consistency and give body to the food (Aremu *et al.*, 2008) [4].
The water absorption capacity of UTDM, DRDM and GDM was found to be 1.47 ±0.05 ml/g, 1.23 ± 0.05 ml/g and 1.33 ± 0.05 ml/g respectively. The significant (p≤0.05) decrease of 15.91% and 9.09% in water absorption capacity of DRDM and GDM can be attributed to the pre-treatments dry roasting and germination respectively. An increase of water absorption capacity on germination than on dry roasting could be attributed to an increase in protein content and change in the quality of protein and also due to breakdown of polysaccharide molecules. Thus, the sites for interaction with water and holding water would be increased (Chauhan *et al.*, 2013) [7]. Among other factors affecting water absorption there are: type of proteins, degree of their denaturation and amount of fibre present in processed cereal material (Zapotoczny *et al.*, 2006) [20].

Oil absorption capacity

The oil absorption capacity of UTDM, DRDM and GDM was found to be 0.77 ±0.05 ml/g, 0.53 ± 0.05 ml/g and 0.43 ± 0.05 ml/g respectively. There was 30.44% and 43.49% significant (p≤0.05) decrease in oil absorption capacity in dry roasted amaranth grain dosa mix (DRDM) and germinated amaranth grain dosa mix (GDM) respectively. The difference in oil absorption capacity could be attributed to change in the quality of protein upon germination or dry roasting.

Emulsion capacity

The emulsification capacityof UTDM, DRDM and GDM was found to be 3.72 ± 0.006 %, 3.12 ± 0.004 % and 3.42 ± 0.006 % respectively. There was 16.23% and 8.09% significant (p≤0.05) decrease in emulsification capacity in dry roasted amaranth grain dosa mix (DRDM) and germinated amaranth grain dosa mix (GDM) respectively. There is 10.71% significant ($p \leq 0.05$) increase in emulsification capacity in dry roasted amaranth grain dosa mix (DRDM) when compared to germinated amaranth grain dosa mix (GDM).

Swelling capacity

Swelling power is the hydration capacity of starch which is expressed as the weight of centrifuged swollen granule, divided by the weight of the original dry starch used to make the paste (Shimelis *et al.*, 2006) [17].

The swelling powerof UTDM, DRDM and GDM was found to be 3.57 ± 0.04, 3.01 ± 0.02 and 5.42 ± 0.11 respectively. There was 15.89% significant ($p \leq 0.05$) decrease in the swelling power in the dry roasted amaranth grain dosa mix (DRDM). The decrease in swelling power could be due the dry heat processing on roasting

There was 51.71% significant ($p \leq 0.05$) increase in swelling power in the germinated amaranth grain dosa mix (GDM) compared to UTDM. The variation in the swelling power indicates the degree of exposure of the internal structure of the starch present in the flour to the action of water (Ruales *et al.*, 1993) [16]. The formation of protein-amylose complex in native starch and flour may impact the swelling power (Pomeranz *et al.*, 1991) [15].

3.3 Sensory Characteristics

The organoleptic scores were recorded in table 6

Table 6: Sensory analysis of experimental Dosa mixes

Sensory attributes	UTDM	DRDM	GDM
Appearance	7.93 ± 0.59	7.86 ± 0.64	7.93 ± 0.79
Colour	7.66 ± 0.72	7.73 ± 0.70	7.86 ± 0.52
Texture	7.33 ± 1.04	7.86 ± 0.83	7.73 ± 0.59
Tear ability	7.66 ± 0.62	7.73 ± 0.96	8.00± 0.37
Aroma	7.86 ± 0.74	7.66 ± 0.97	7.86 ± 0.63
Taste	7.66 ± 0.82	8.06 ± 0.88	7.80± 0.56
Mouthfeel	7.53 ± 0.64	7.80± 0.86	7.66 ± 0.49
Overall acceptability	7.73 ± 0.59	8.06 ± 0.07	7.80± 0.41

The UTDM, DRDM and GDM scored 7.73 ± 0.59, 8.06 ± 0.07 and 7.8 ± 0.41 for the overall acceptability respectively. There was no significant difference between the scores of all the three Dosa mixes at $p<0.05$. The DRDM was most acceptable by the sensory panellists.

The panellists have rated the overall acceptability of DRDM the highest score of 8.06 being "Like very much".

4. Conclusion

This research was carried outto utilize gluten free, nutritious and low cost amaranth grains, bengal gram dal and vegetables to produce a convenience food that can be consumed by celiac patients in India that provides a cereal-pulse balance as well. The nutritional, functional and organoleptic properties of the experimental dosa mixes were studied. Pre-treatments: roasting and germination of amaranth had a significant impact on its nutrient profile and functional properties. However there was no significant difference in their sensory attributes. The study recommends germination of amaranth grains for its better nutritive value and its utilisation in the preparation of the traditional recipe-dosa.

5. Reference

1. Advisory Committee on Technology Innovation (A.C.T.I.), Board on Science and Technology for International Development (B.S.T.I.D.), Office of International Affairs, National Research Council (N.R.C). Amaranth: Modern Prospects for an Ancient Crop. Washington D.C. National Academy Press, 1984, 3.
2. AOAC. Official Method of Analysis. 15th Edition, Association of Official Analytical Chemists, Washington DC, 2006.
3. AOAC. Official methods of analysis, 17th edition. Association of Official Analytical Chemists, Washington DC, 2000.
4. Aremu MO, Olaofe O, Akintayo ET, Adeyeye EI. Foaming, water absorption, emulsification and gelation properties of cresting's groundnut (*Kerstingiellageocarpa)* and Bambara groundnut *(Vigna subterranean*) flour as influenced by neutral salts and their concentrations. Pak. J Nutr. 2008; 7(1):194-201.
5. Berghofer E, Schoenlechner. Belton PS(ed) and Taylor JRN(ed). Pseudocereals and Less Common Cereals: Grain Properties and Utilization Potential. New York. Springer-Verlag Berlin Heidelberg, 2002, 218- 219
6. Caselato-Sousa VM, Amaya-Farfán J. State of knowledge on amaranth grain: a comprehensive Review. Journal of Food Science. 2012; 77(4):R93-104.
7. Chauhan A, Singh S. Influence of Germination on Physico-chemical Properties of Amaranth (*Amaranthus Spp.*) Flour. International Journal of Agriculture and Food Science Technology. 2013; 4(3):215-220.
8. Chauhan A, Saxena DC, Singh S. Total dietary fibre and antioxidant activity of gluten free cookies made from raw and germinated amaranth (Amaranthus spp.) flour. LWT-Food Science and Technology, 2015; 63**:**39-945. doi:10.1016/j.lwt.2015.03.115
9. El-adawy TA, Rahma EH, El-Bedawey AA, El-Beltagy AE. Nutritional potential and functional properties of germinated mung bean, pea and lentil seeds. Plant Foods for Human Nutrition. 2003; 58:1-13.
10. FAO. Food energy – methods of analysis and conversion factors. Food and Nutrition paper, 2003. (ISSN 0254-4725)
11. James CS. General Food Studies. In: Analytical Chemistry of Foods, Chapter 6, Blachie Academic & Professional, 1995, 137-171
12. Mota C, Santos M, Mauro R, Samman N, Matos AS, Torres D, *et al*. Protein content and amino acids profile of pseudocereals. Food Chemistry. 2016; 193:55-61.
13. Nagaprabha P, Jamuna P. Development and quality assessment of green gram based instant dosai mix. Journal of Food Science and Technology, 2009; 46(5):418-422.
14. Peryam DR, Pilgrim FJ. Hedonic scale method of measuring food preference. Food Technology, 1957; 11:9-14.
15. Pomeranz Y. Functional Properties of Food Components. New York. Academic Press, Inc, 1991, 27-28.
16. Ruales J, Valencia S, Nair B. Effect of Processing on the

Physicochemical Characteristics of Quinoa Flour (Chenopodiumquinoa, Willd). Starch. 1993; 46(1):13-19.
17. Shimelis EA, Meaza M, Rakshit S. Physico-chemical Properties, Pasting Behavior and Functional Characteristics of Flours and Starches from Improved Bean (Phaseolus vulgaris L.) Varieties Grown in East Africa. Agricultural Engineering International: The CIGR Ejournal. 2006; 8:FP05-015.
18. Shittu TA, Dixon A, Awonorin SO, Sanni LO, Maiya-Dixon B. Bread from composite cassava-wheat flour. II: Effect of Cassava Genotype and Nitrogen Fertilizer on Bread Quality. Food Research International. 2008; 41:569-578.
19. Uwaegbute AC, Iroegbu CU, Eke O. Chemical and Sensory Evaluation of Germinated Cowpeas (*Vignaunguiculata*) and their Products. Food Chemistry. 2000; 68(2):141-146.
20. Zapotoczny P, Markowski M, Majewska K, Ratajski A, Konopko H. Effect of temperature on the physical, functional, and mechanical characteristics of hot-air-puffed amaranth seeds. Journal of Food Engineering. 2006; 76:469-476.