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A Study on the consumer acceptance, Nutritive value and Antioxidant activity of Multigrain Ladoo

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Abstract
Food Based approaches are recognized as an essential part of an urgently needed more comprehensive strategy for improving nutrition by increasing the availability and consumption to combat nutrient deficiencies. It is also needed to ensure food and nutrient security among the vulnerable sections of the society. The present study was carried out to develop an innovative traditional nutritious product – multigrain ladoo and to assess the consumer acceptance, nutritive value and its antioxidant content. Quasi-experimental design was used to assess the consumer acceptance (using 9 point hedonic rating scale) of the developed product. Nutrient and antioxidant content of the product was also determined (Lab analysis). Using ex-post facto research design a general survey (using interview schedule) was carried out to determine the sensory evaluation among the subjects (n=50) who were selected using purposive sampling technique. From the study we could observe that appearance, texture, colour, aroma, mouthfeel, taste and overall product score of multigrain ladoo by 9 hedonic scale rating was remarkable, significance level being 1%.Thus the product proved to be highly acceptable by the consumers. Nutrient (especially for protein, carbohydrate, iron and phosphorus) and antioxidant content of the product was also tremendously high. Multigrain ladoo is a product providing most of the nutrients especially proteins, carbohydrate, iron and phosphorus and has good antioxidant content. The overall product was highly acceptable by the consumer. Hence we could suggest multigrain ladoo for the subjects so that they could be healthy and overcome from certain nutrient deficiencies.

Keywords: food based approach, millets, nutrient deficiencies, multigrain ladoo

1. Introduction
Millet is a generic term used for small sized grains that form heterogeneous group and referred along with maize and sorghum as 'coarse cereals'. Millets are of minor importance in the west but a staple food in the diets of African and Asiatic people. Their agricultural importance arises from their hardness, tolerance to extreme weather and could be grown with low inputs in low rainfal areas. Bajra or pearl millet or kambu (Pennisetum americanum), ragi or finger millet (Eleusine coracana), thinai or foxtail millet (Setaria italica), samai or little millet or samai (Panicum miliare), haraka or kodo millet or varagu (Paspalum scrobiculatum), panivaragu or proso millet (Panicum miliaceum), banti or barnyard millet (Echinochloa frumentacea) are the important millets cultivated largely in the Asian and African countries.
Millets have relatively poor digestibility and low bio-availability of minerals due to presence of inherent anti-nutritional factors. An increasingly important determinant in food choice is the growing consumer concern about nutrition and health (Nehir and Simsek, 2012). The difficulties in millet grain processing present a challenge but nutritional as well as health benefits and consumer demand for health foods provide opportunities in processing, development of suitable technology for newer products and process mechanization. This change in technology and consumer food preference would help in increasing the area under millets, maintaining ecological balance, ensuring food security, prevent malnutrition and increase the scope for utilization of millet grains on industrial scale.
Different studies on processing of millets have yielded promising results in their successful utilization for various traditional as well as convenience health foods. Accordingly different researchers have tried to develop processed products like popped, flaked, puffed, and extruded and roller dried products; fermented, malted and composite flours; weaning foods, etc. For example, exploratory studies on popping and milling of millets have been promising

(Malleshi, 1986). Extrusion of weaning foods of pearl millet increases the protein digestibility (Cisse *et al*., 1998) whereas germination and probiotic fermentation causes significant improvement in protein profile and in-vitro mineral availability (Arora *et al*., 2011). In order to understand the miracle of millet grains, their process ability, present status of range of food products and future scope for development of millet based health, functional and RTE products, it is attempted to review the composition, specialties of ingredients, different food products from millets, processing techniques, their effect on nutrients and product characteristics.

Demand for millets can be increased by creating awareness regarding their environmental sustainability, nutritional and other health benefits, by incorporating in value added products, by inclusion under feeding programs like mid-day meal, Integrated Child Development Services (ICDS) feeding, and adolescent girls nutrition scheme (now under consideration of Ministry of Women and Child Welfare) and product development of mille

Cereal and millets form the basic diet for millions of people throughout the world. They are major sources of inexpensive dietary energy and nutrients world-wide. When compared to other fermentable substrates, cereals and millets are superior in nutritional quality as these abundant resources contain some of the essential minerals, vitamins, sterols, growth factors and dietary fibres thus satisfying essential nutrient needs of mankind. Other than these nutritional advantages, cereals and millets contain prebiotic components which support the survival of functional microbes in gastric transit. Short oligosaccharides, resistant starch, polysaccharides and dietary fibres are recognized as prebiotics (Macfarlane *et al*., 2006). Any cereal substrates naturally contain at least two of the oligosaccharides (Henry and Saini, 1989) which possess different physiological functions. Also the presence of resistant starch and dietary fibres in cereals serve as encapsulation materials for probiotic microbes. Food processing techniques like sprouting improves the bioavailability of nutrients and enhances the nutritional significance of cereals and millets.

Sprouting process provides nutritionally balanced, energy-dense, easily digestible foods with functional benefits. A Cost-effective, nutritious food, which is easily assimilated by the body and which promotes growth and healing is obtained by sprouting. To achieve this objective, use of seasonal, local, low-cost and abundantly available raw food ingredients having high nutrition and functional properties like cereals, coarse cereals and millets, green gram, ingredients and horticultural produce should be advocated.

Hence the present study was aimed at developing a multi-grain ladoo with millets, sprouted pulses, and cereal combination and its consumer acceptance, antioxidant activity and nutritive value was analyzed.

Development of traditional sweet like ladoo using combination of cereals, millets and sprouted pulses would signify the effective utilization and optimization of these locally grown inexpensive grains and grams which improves the economy of developing countries and also promotes the traditional values that are native of the country. Sweets could be consumed anywhere and anytime and are acceptable by the consumers. Hence the product developed; multi-grain ladoo would be a consumer acceptable propitious low cost nutritious traditional sweet.

Hence the present study was carried out to determine the consumer acceptance, antioxidant activity and nutritive value of multi-grain ladoo.

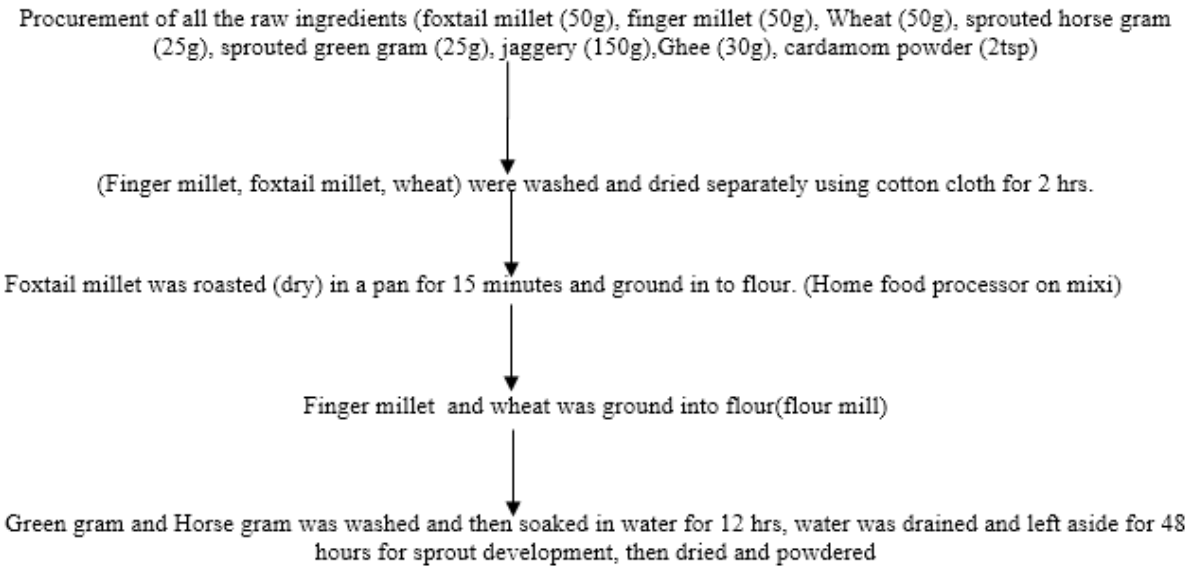
2. Material and Method

In this research work two basic millets (finger millet and foxtail millets), two sprouted pulses (green gram dhal and horse gram dhal), wheat, ghee, jaggery, cardamom powder were purchased from local commercial market.

Table 1: Composition of raw materials used in the multigrain ladoo

Ingredients	Amount
Finger millet	50g
Foxtail millet	50g
Wheat flour	50g
Sprouted green gram	25g
Sprouted horse gram	25g
Jaggery	150g
Ghee	30g
Cardamom powder	2tsp
Yield	10 multigrain ladoo (30g of each ladoo)

Procurement of all the raw ingredients (foxtail millet (50g), finger millet (50g), wheat (50g), sprouted horse gram (25g), sprouted green gram (25g), jaggery (150g), ghee (30g), cardamom powder (2tsp)



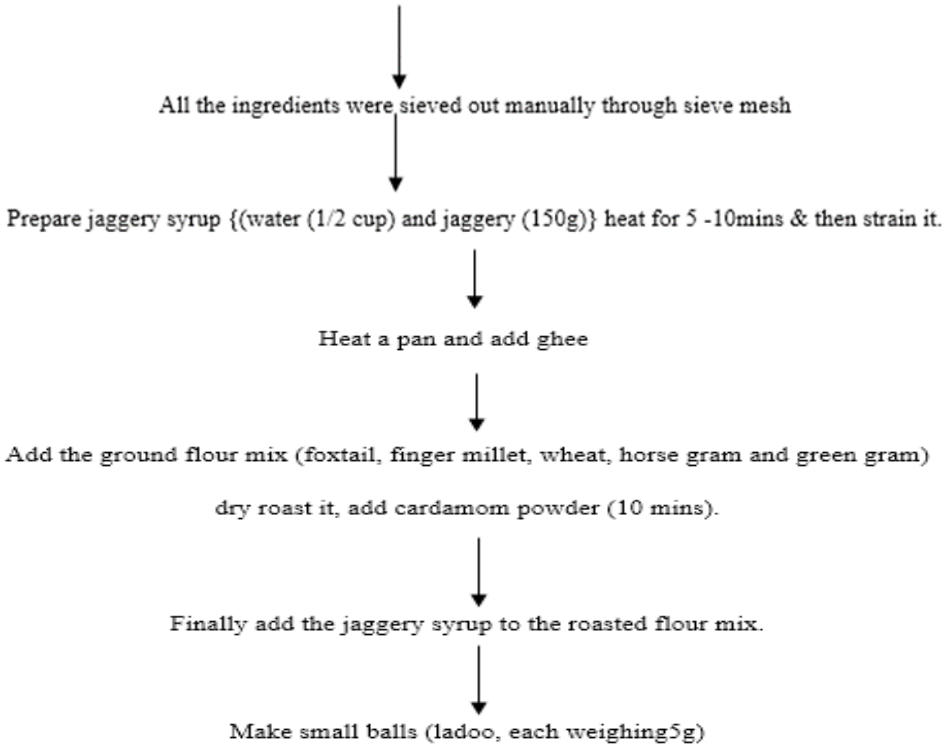


Fig 1: Flow Chart for Preparation of Multigrain Ladoo

2.1. Consumer acceptance, Nutrient analysis and determination of antioxidant content of multigrain ladoo:

Quasi-experimental design was used to assess the various sensory attributes influenced by the developed multigrain ladoo among the subjects using 9 point hedonic rating scale.

The multigrain ladoo [(foxtail millet (50g), finger millet(50g), wheat (50g), sprouted horse gram (25g), sprouted green gram (25g), jaggery (150g), ghee(30g), cardamom powder(2tsp)] was analyzed for the following nutrients moisture, energy, protein, fat, carbohydrate, crude fibre, iodine, iron, copper, manganese, zinc, selenium, magnesium, calcium, phosphorous. Antioxidant activity of raw ingredient and cooked multigrain ladoo was also assessed using Gallic acid method. Nutrient analysis and determination of antioxidant activity was carried out in "FOOD TESTING LAB".

2.2. Processing and analysis of Data

In the present study processing of data was done to determine the consumer acceptance, nutritive value and antioxidant activity of the developed multigrain ladoo. The results were tabulated and analyzed using statistical method. Both inferential and descriptive statistical methods were used for data analysis.

Under descriptive statistical analysis methods, percentage analysis and mean were used to describe the data. 't' test and one way ANOVA test were the inferential statistical methods used to analyze data. Statistical package for social science (SPSS) was used to compute analysis data.

3. Result and Discussion

3.1. Consumer Acceptance and prefernce of Multigrain Ladoo

Details regarding consumer acceptance and preference of multigrain ladoo was tabulated and discussed below

Table 2: Consumer Acceptance of Multigrain Ladoo

Variables	N	Test Value	MEAN	SD	SE	"t" value
Appearance	50	10	8.32	0.741	0.105	16.039**
Texture	50	10	8.38	0.753	0.106	15.214**
Colour	50	10	8.32	0.768	0.109	15.474**
Aroma	50	10	8.22	0.864	0.122	14.567**
Taste	50	10	8.54	0.646	0.091	15.992**
Mouth Feel	50	10	8.52	0.735	0.104	14.236**
Overall Product	50	10	8.68	0.513	0.073	18.205**

**- significant at one percent level.

The above table (2) shows, the mean score for appearance of the product, it was 8.32 ± 0.741, which was significant at 1%level. This shows that the product developed was found to be highly acceptable with respect to appearance. The mean value of texture was 8.38 ± 0.753, which was significant at 1% level. This proves that the multigrain ladoo was found to have good texture. The mean value of colour was 8.32 ± 0.768, which was significant at 1% level. This shows that the product was found to be highly acceptable by its colour. The mean value of aroma was 8.22 ± 0.864, which was significant at 1% level. This reveals the fact that multi-grain ladoo was found to be good and acceptable with respect to aroma. Compared to other variables aroma score was found to be slightly less but was significantly acceptable among the subjects. The mean score for taste was 8.54 ± 0.646, which was significant at 1%level. This shows that the product was highly acceptable by its taste. The mean value of mouth feel was 8.52 ± 0.735, which was significant at 1%level. This proves that the product

developed had a good mouth feel. The mean score of overall product was 8.68 ± 0.513, which was highly significant at 1%level. This shows that the overall product score was significantly high and hence multigrain ladoo was highly acceptable by the consumers.

It can be observed that appearance, texture, colour, aroma, mouthfeel, taste and overall product score of multigrain ladoo was remarkable. Thus the product proved to be a consumer acceptable product. This was similar to another study carried out by Gautham *et al*, (2014) [17] who analyzed the organoleptic qualities of the extruded product sample using panelists on 9 point hedonic scale. The result indicates that the processed composite flour (foxtail millet, wheat, chick pea) based product were significantly accepted at the level of $p<0.05$, for 50% incorporation of the composite flour followed by 75% and 100% respectively.

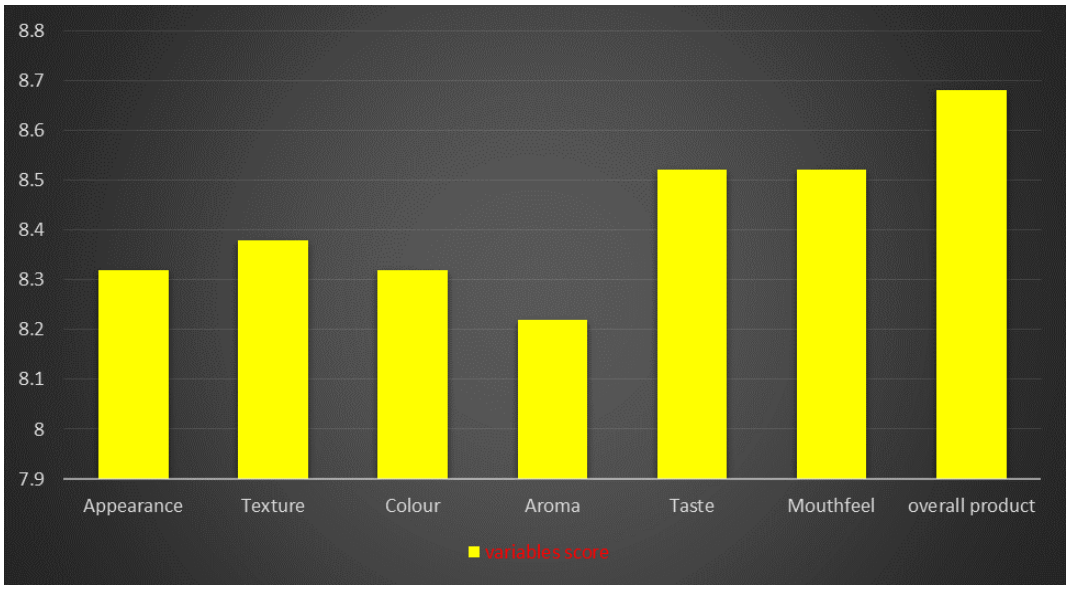


Fig 2: Consumer Acceptance of Multigrain Ladoo

3.2 Nutrient Content of Multi-Grain Ladoo

The nutrient content of multi-grain ladoo is discussed under the headings,

1. Macronutrient content of multi-grain ladoo (where carbohydrate, fat, protein and fibre were discussed)
2. Micronutrient content of multi-grain ladoo (where calcium, iron, phosphorus, selenium, manganese, magnesium, copper and zinc were discusse

3.2.1 Macronutrient Content of Multigrain Ladoo

Table 3.

Nutrient Analysis	Moisture G/100g	Energy Kcal/100g	Protein G/100g	Fat G/100g	Cho G/100g	Crude Fibre -
Lab Report	8.82	388.72	9.22	6.56	73.17	-

The above table 3 denotes, the nutrient analysis of multigrain ladoo, the moisture content in the product was found to be 8.82g/100g, energy content was 388.72kcal/100g, protein content was 9.22 g/100g, fat content was 6.56g/100g and carbohydrate content was 73.17g/100g.

While comparing the protein content and carbohydrate content from the above data (9.22g/100g and 73.17g/100g, respectively) with the protein value and carbohydrate value obtained (8.5g/100g and 65g/100g respectively) from nutritive value of Indian foods book (2009) we could infer that the protein content and carbohydrate content analyzed through the lab report was tremendously high compared to the value specified in the nutritive value book this could be due to the processes carried out during multi-grain ladoo preparation like sprouting. This was in par with another similar study carried out by Gautham *et al*, 2014 [17] which showed that Namakeen sev made by incorporating malted mixed flour (foxtail millet flour, chick pea flour, wheat flour) in different concentration (50%,75%,100%) had higher amount of moisture 11.6g/100g, protein 13.9g/100g and carbohydrate63.7g/100g. The product developed had no fibre content (as specified in the lab report), this could be due to sieving process which could have removed the fibre content and hence would have increased the bio-availability of other nutrients

The fat content was found to be less (6.56g/100g obtained from lab report) when compared to the value (11.3) obtained from nutritive value book, this could be due to degradation of fat as mentioned in another similar study which reported that fats were degraded significantly ($p\leq0.05$) during sprouting/malting. The malted finger-millet or sprouted green gram present in a multi nutrient mixes where nutritional and functional properties were studied and compared with their un-sprouted counterparts. (Dipika Agrahar Murugkar *et al*., 2013)

3.2.2 Micronutrient Content of Multigrain Ladoo

Table 4.

Nutrient Analysis	Calcium Mg/100g	Iron Mg/100g	Phosp Horus Mg/100g	Cu mg/100g	Mg mg/ 100g	Zinc mg/ 100g	Se mg/ 100g	Mn mg/100g
Lab Report	14.8	4.21	885	0.3	60.6	1.72	1.0	3.51

Cu-Copper, Mg-Magnesium, Se- selenium, Mn- manganese.

The above table 4 shows, the micronutrient content of multigrain ladoo which was given as follows ;calcium content 14.8mg/100g, iron content 4.21g/100g, phosphorus content 885mg/100g, copper contains 6.56mg/100g, magnesium contains 60.6mg/100g,zinc contain 1.72mg/100g, selenium contains1.0mg/100g, manganese contain 3.51mg/100g.

On comparing the nutrient content of the lab report with nutrient content computed using nutritive value book we could analyze that iron content was 4.21mg/100g in the lab analysis which was higher compared to the amount computed from nutritive value book. This was similar to another study which showed that namakeen sev made by incorporating malted mixed flour (FMF+CPF+WF) in different concentration (50%,75%,100%)was subjected to compositional analysis, the results showed that the composite flour consist of 4.1mg/100g of iron.(Gautham *et al*., 2014) [17]

On contrast phosphorus content (229mg/100g), Zinc content (1.4mg/100g), Manganese content (1.52mg/100g) was profoundly less when compared with values obtained from laboratory analysis. Copper content was found to be similar in both the lab analysis and value obtained from nutritive value of Indian foods (0.3mg/100g)

3.3. Antioxidant Content of Raw Ingredients and Cooked Multigrain Ladoo

The cooked multigrain ladoo contains 618 µg/100g of antioxidant content. The raw ingredients which was used to prepare multigrain ladoo and their antioxidant level are as follows; finger millet 268 µg/100g, foxtail millet 340 µg/100g, wheat 197 µg/100g, cardamom powder 182 µg/100g, ghee 80.1 µg/100g, horse gram sprouted and green gram sprouted together 662 µg/100g, jaggery 115 µg/100g.

The sprouted horse gram and sprouted green gram powder had high level of antioxidant. Hence it denotes that sprouted pulses have high antioxidant content. This was confirmed with another similar study carried out by Dipika Agrahar Murugkar which showed that on sprouting the antioxidant capacity of all mixes increased significantly ($p \leq 0.05$) due to increase in activity of antioxidant enzymes like superoxide dismutase, glutathione peroxidase, catalase etc. (Dipika Agrahar Murugkar *et al*., 2013) We could also observe that the level of sprouted ingredients was high compared to cooked product this could be due to oxidation of vitamin C the potential antioxidant, during cooking process (on subjection to heat).

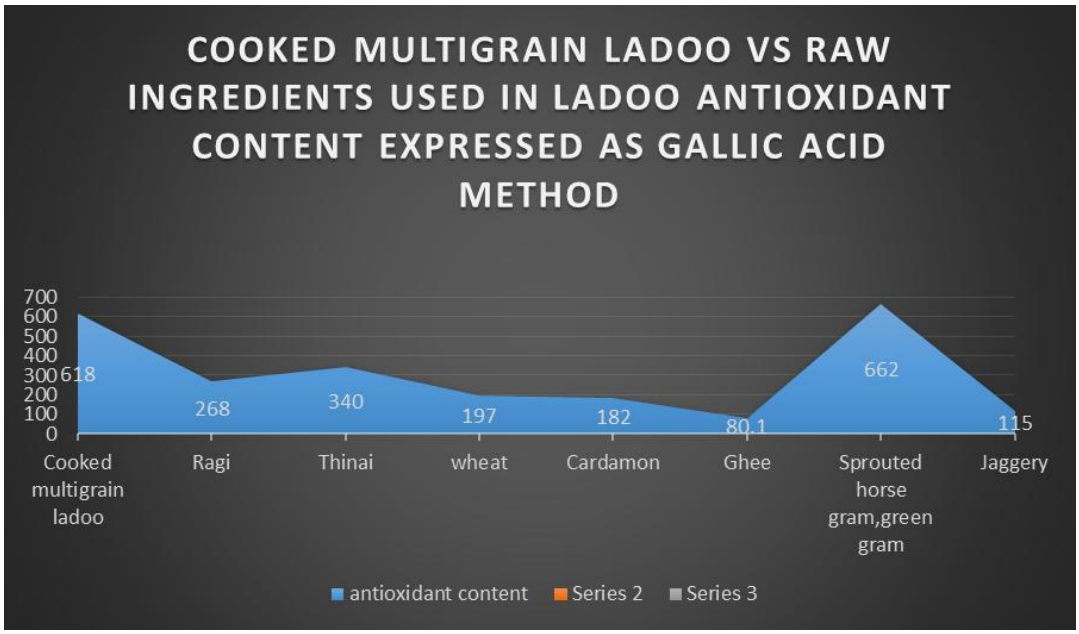


Fig 3.

Suggestion for Further Research

- The study could be carried out with a larger sample size and for a longer period of time.
- Comparative study could be carried out using different sample proportions of the various ingredients.
- Studies with other cereals, millets and pulse combinations could be carried out with various traditional recipes.

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