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Research Article

Quality Evaluation of Various Millets and Other Grains Used in Traditional Indian Cuisine and Study of Their Nutritional Potential

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Abstract

The evolution of food took place over time, along with the development of agricultural practices. Various species of food grains were identified, which significantly strengthen the food chain. Millets were used as the main ingredients of a daily diet, but over time, their use gradually decreased. Initially, the side effects of modern foods were not felt, but with an increase in lifestyle diseases, humans started realizing the bad effects of modern foods, which forced re-identification, protection, and revival of healthy foods. As a result, the health benefits of millets and other grains were re-identified and re-established. With the above facts, an attempt has been made to compare the nutritional strength of wheat with that of some important millet and other flours, focusing on their potential health benefits. This comparative study dealt with the evaluation of millet and other flours like rajgira or amaranth ramdana (Amaranth - *Amaranthus caudatus* L.), ragi ;finger millet - *Eleusine coracana* (L.) Gaertn.], jowar (sorghum - *Sorghum bicolor* L. Syn. *Sorghum vulgare*), bajra (pearl millet - *Pennisetum glaucum* (L.) R. Br.), singhada (chestnut - *Trapa natans* L.), chawal (rice - *Oryza sativa* L.), makka (maize – *Zea mays* L.) and gehu (wheat - *Triticum aestivum* L.) flour. An attempt has been made for standardization of various flours, primarily as per BIS and FSSAI guidelines, including moisture, pH, total and acid insoluble ash, bulk density, water and oil absorption capacity, swelling and foaming index, foam stability, emulsion stability, and emulsion activity, and a comparative assessment of their nutritional facts like total fat, total carbohydrates, dietary and crude fiber, calories, caffeine, protein, gluten, cholesterol, and sodium energy content, to reach conclusive recommendations. The obtained result revealed millets and rice are equal or high in possessing nutritional values compared to wheat flour and provide a significant contribution to a routine diet as a staple food.

Keywords: gluten-free, millets, pseudo cereals, flour standardization, nutritional profiling.

1. Introduction

The development of food items took place over time along with various types of struggles for the survival of human being. Initially, non-vegetarianism was prominent in the food; slowly vegetarianism percolate into the human food habits which results diversified food items. In the course of development of food items, in the beginning, fruits, vegetables, tubers etc. had a prominent place, which were mainly found in natural habitats in abundance and were sufficient for cater the needs. With the development of agricultural practices, various species of grains were identified for consumption as food.

In the present world scenario, millets are considered to be an important crop like other grains grown across the world including wheat, rice, maize and barley etc[1].The production of millets during initial phase of food chain development was not sufficient to cater human race; thus, identification of new species of grains and their breeding opens a avenue of high yielding varieties capable to serve the large population. This evidence more dependency on new food grains and divert the focus from the millets. Wheat and other fine grains slowly created the place into the main course of the cuisine over the millets. In most of the part of the world especially less rain fed regions; millets are good answer for serving the population due to its survival capacity in terms of tough geo-climatic conditions, resistance to disease and pests and their significantly high yielding capacity. This segment of food grains are generally considered as healthy food[2]. Millets are proven rich source of photochemical, minerals, vitamins, antioxidants and dietary fiber with low calories which offer several health benefits like boosting immunity, improve gastrointestinal system and generally considered as best gluten free food[3,4]. The demand for gluten-free alternatives to traditional foods like bread and pasta has increased due to celiac disease, an immune-mediated condition brought on by consuming the protein contained in wheat known as gluten. Nevertheless, the products which gluten-free are in the market have a significant prevalence of nutritional inadequacies[5].

The present study deals with few Coarse Grains[6] which includes barley, maize, finger millet, pearl millet, sorghum, and other five additional "Small Millets" species[7]. Given the current global focus on millets, particularly in the context of Millet's Year, this paper highlights the nutritional significance of these ancient grains. The analysis also emphasizes the potential health drawbacks associated with wheat consumption, further underscoring the need for a diversified approach to flour selection. This research paper delves with a comparative evaluation of flours derived from millets and other nutritionally important grains, *viz*., rajgira or amaranth ramdana (Amaranth - *Amaranthus caudatus* L.), ragi (finger millet - *Eleusine coracana* (L.) Gaertn.), jowar (sorghum - *Sorghum bicolor* L. Syn. *Sorghum vulgare*.), bajra (pearl millet - *Pennisetum glaucum* (L.) R. Br.), singhada (chestnut - *Trapa natans* L.), chawal (rice - *Oryza sativa* L.), makka or corn (maize – *Zea Mays* L.) and gehu (wheat - *Triticum aestivum* L.) in order to reveal the nutritional foundations and another is to find new ways to address the nutritional issues that gluten-free diets have historically had.

Research indicates the evolution of dietary preferences from millet-based flours to wheat and other flours is explored, shedding light on the transition in ancient culinary practices. Given the current global focus on millets, particularly in the context of Millet's Year underscoring the need for a diversified approach to flour selection. Through this research an attempt has been made to analyzed different attributes of test flours as per FSSAI guidelines. The parameters like Color, taste, texture, pH, moisture content, total and acid insoluble ash, bulk and tap density, water and oil absorption capacity, swelling and foaming index and a comparative assessment of their nutritional facts like total fat, total carbohydrates, dietary fiber, crude fiber, calories, protein, caffeine, gluten, sugars and cholesterol has undertaken to reach conclusive recommendations.

By doing this, it hopes that it shed the light on potential nutritional solutions and to provide a wise dietary decisions and ushers in a paradigm change towards more nutrient-rich and balanced gluten-free options by illuminating the nutritional tapestry of these flours.

2. Material and Methods

Eight samples of food grains as shown in Plate 1, were procured from different suppliers operating in the Wardha local market (Maharashtra - India). All the samples were sieved with different sieve sizes, cleaned and thoroughly washed with tap water and dried using tray dryer (40-45°C) to get dirt and foreign material free clean samples for study. The samples were crushed using grinder. To ensure the preservation of their properties, all the samples were stored in airtight plastic zip bags at room temperature. Proximate composition measurements were carried out in triplicate.

The samples were analyzed for their physical attributes viz. color, taste and texture as per method described by Olaoye[8] and foreign matter (FSSAI[9]).Various Physico-chemical parameters were studied as per standard protocols. pH of the samples was checked by using Digital pH Meter (Erma-pH-025M) and moisture percent was calculated by SARTORIUS MA150 (Sartorius, Germany) analyzer. Similarly, fat content (Nagi[10]); crude fiber (AOAC[11]); total and acid insoluble ash were analyzed as per API (FSSAI[9]); total carbohydrate (James[12]); Protein content estimated by Kjeldahl method (AOAC[11]); total energy content in (kcal) of the sample (Pearson[13]); Gluten content, total dietary fiber and Caffeine (BIS[14,15]); cholesterol (Al-hasani[15]); Sodium (Kathrin[16]) were also estimated. The functional characteristics like bulk density(Jones[17]); swelling capacity (Okaka & Potter[18]); oil absorption capacity and water absorption capacity(Sosulski[19]); foam capacity and foam stability (Narayana[20]); emulsion stability and emulsion activity (Yasumatsu[21]) were assessed.

3. Results and Discussion

a. Physico-chemical properties of flour

All the samples were found free from foreign matter. The grinded test flour samples having different colors, texture and taste like flour of wheat was found white in color, smooth in texture and tasteless; Amaranth was yellowish white in color, smooth in texture and tasteless; Rice was bright white in color, rough in texture and tasteless; Ragi flour was white with brownish tinge in color, smooth in texture and tasteless; Jowar was found off white in color, smooth in texture and tasteless; sample of Bajra was greyish white in color, smooth in texture and tasteless; Maize flour found light yellow in color, smooth in texture and tasteless; Chestnut, light grayish white in color, smooth in texture and tasteless. The physico-chemical parameters were studied and shown in Table 1 and Fig.1; pH of flours was ranged between 5.2 to 7.5%. The highest pH was found in Jowar (7.5%) while lowest in wheat 5.2% flour. The moisture content was observed highest in rice14.1% as well as lowest 10.0%in amaranth flour. The study revealed fat content ranged with the maximal 5.1% in rice and least in bajra (1.1%). Likewise, the total ash content was detected in between 0.07 to 2.5% with the highest value in amaranth (2.5%) and minimal in wheat (0.07%). Furthermore, the acid insoluble ash content was ranged from 0.01 to 0.16% with the highest in amaranth (0.16) and slightest in wheat (0.01%). The value of crude fiber was observed in a range of 0.2 to 2.8% among all the flours. It was highest in bajra (2.8%) whereas minimal in chestnut (0.2%). The carbohydrate of test samples under observation was detected between 64.82 to 76.80% among all the flours. The utmost carbohydrate was observed in chestnut flour (76.80%) while lowest was in wheat (64.82%). The protein content of flours undertaken for study was detected 7.59 to 14.83%.

Table 1: Physico-chemical properties of individual flours

Sl. No.	Flour Samples	pH	Moisture (%L)	Fat (%)	Total Ash (%)	Acid Insoluble (%)	Crude Fibre (%)	Total Carbohydrate (%)	Protein (%)	Gluten (%)	Total dietary fiber (%)	Cholesterol (%)	Caffeine (%)	Energy (Kcal)	Sodium (%)
01	Wheat	5.2±0.205	12.7±0.2	4.2±0.100	0.07±0.02	0.01±0.011	1.82±0.08	64.82±0.275	10.18±0.315	15.99±0.148	12.1±0.175	0	0	400±2.00	1
02	Amaranth	6.0±0.08	10.0±0.16	3.9±0.464	2.5±0.294	0.16±0.014	0.6±0.36	67.74±0.320	14.83±0.465	00	10.7±0.520	0	0	432±2.86	1
03	Chestnut	6.3±0.141	10.4±0.37	3.5±0.575	0.4±0.081	0.06±0.011	0.2±0.020	76.80±0.244	7.67±0.363	00	8.3±0.245	0	0	364±2.86	0.4±0.11
04	Rice	6.1±0.094	14.1±0.21	5.1±0.249	1.5±0.094	0.07±0.016	0.3±0.163	73.56±0.367	7.59±0.503	00	3.5±0.510	0	0	589±2.05	1
05	Ragi	7.2±0.205	10.3±0.24	3.3±0.262	1.7±0.094	0.04±0.016	2.2±0.053	67.70±0.517	8.11±0.388	00	17.8±0.345	0	0	341±2.49	0
06	Jowar	7.5±0.216	12.2±0.28	3.0±0.339	1.8±0.065	0.16±0.099	2.1±0.094	70.96±0.344	8.63±0.274	00	11.9±0.725	0	0	371±2.16	1
07	Bajara	6.1±0.124	13.26±0.57	1.1±0.24	1.9±0.053	0.11±0.012	2.8±0.099	66.10±1.488	10.88±0.519	00	19.74±0.483	0	0	373±3.39	0
08	Maize	6.0±0.163	11.00±0.37	4.4±0.286	1.5±0.169	0.10±0.012	2.4±0.068	65.13±0.695	8.81±0.636	00	12.6±0.770	0	0	382±3.09	1

The highest in amaranth flour (14.83%) while lowest in rice flour (7.59%). Wheat flour contained 15.99% Gluten while other flours samples were found free from gluten. Total dietary fiber content of flours was found highest in bajra flour (19.74%) and lowest in rice flour (3.5%). Cholesterol and caffeine content were also evaluated in the flour samples including wheat but it was observed that all the samples were free from those contents. The energy in Kcal was calculated for all the test flour samples and it was revealed with the highest in rice flour (589 Kcal)

Table 2: Functional properties of individual flours

Sr. no.	Flour Samples	Bulk density (g/cc)	Water absorption capacity (%)	Oil absorption capacity (%)	Swelling capacity (ml)	Foaming capacity (%)	Foam stability (%)	Emulsion activity (%)	Emulsion stability (%)
01.	Wheat	0.768±0.015	116.70±2.897	108.69±0.836	32.65±0.42	26.8±0.342	8.19±0.113	7.68±0.057	5.66±0.080
02	Amaranth	0.503±0.006	204.66±3.299	239.07±0.781	3.07±0.438	16.9±0.074	10.61±0.232	33.38±1.99	45.48±0.595
04	Rice	0.922±0.008	262.00±2.449	154.82±0.365	5.67±0.265	2.60±0.301	1.03±0.125	41.93±0.332	37.35±0.100
05	Ragi	0.815±0.012	119.76±2.169	104.07±0.232	20.91±0.423	14.30±0.21	4.20±0.244	7.61±0.509	13.09±0.037
06	Jowar	0.895±0.042	240.90±0.369	183.73±0.409	22.78± 0.48	9.30±0.064	1.16±0.205	40.31±0.351	40.39±0.070
07	Bajara	0.729±0.049	119.83±0.457	102.87±0.616	14.69±0.48	14.22±0.224	5.93±1.388	13.50±0.579	50.45±0.097
08	Maize	0.743±0.060	169.66±0.507	102.20±0.835	22.68±0.68	8.08±0.061	0.00±0.000	4.53±0.331	30.66±0.049
09	Chestnut	0.697±0.010	200.15±1.021	183.81±0.396	18.4±0.363	15.19±0.143	17.26±0.286	1.83±0.249	49.07±0.046

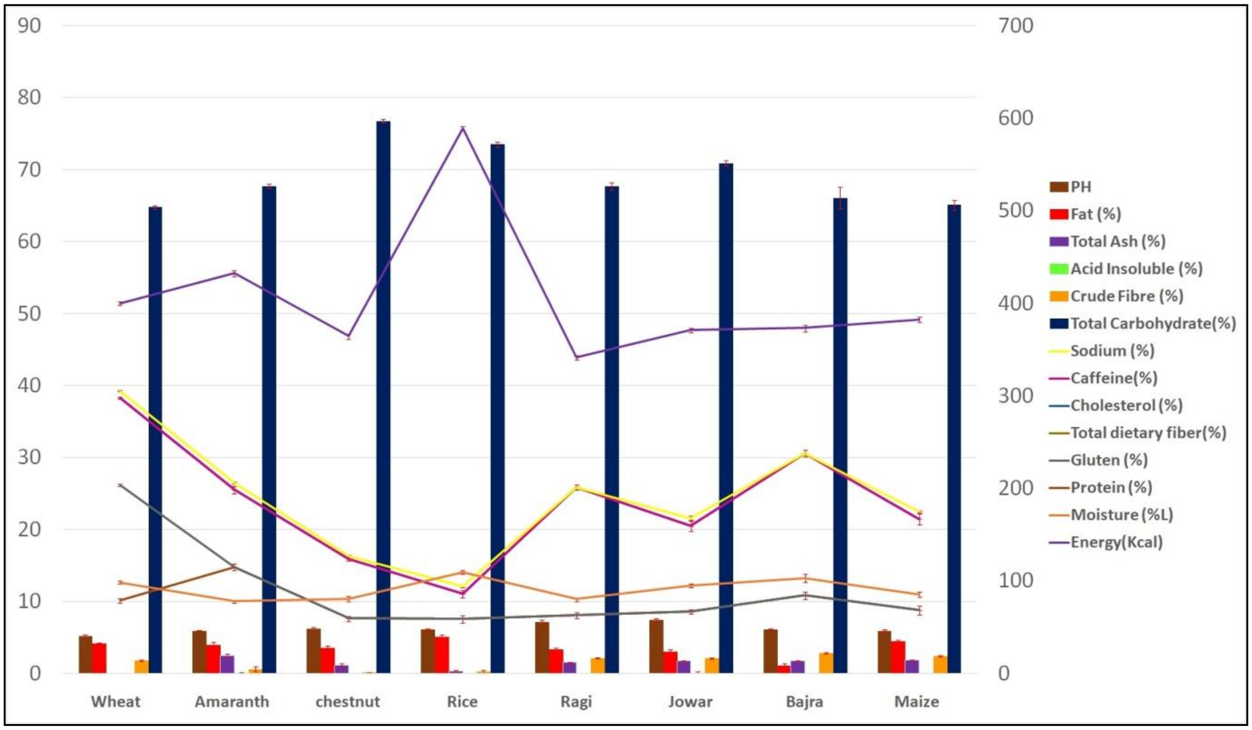

Figure 1: Physico-chemical properties of individual flours

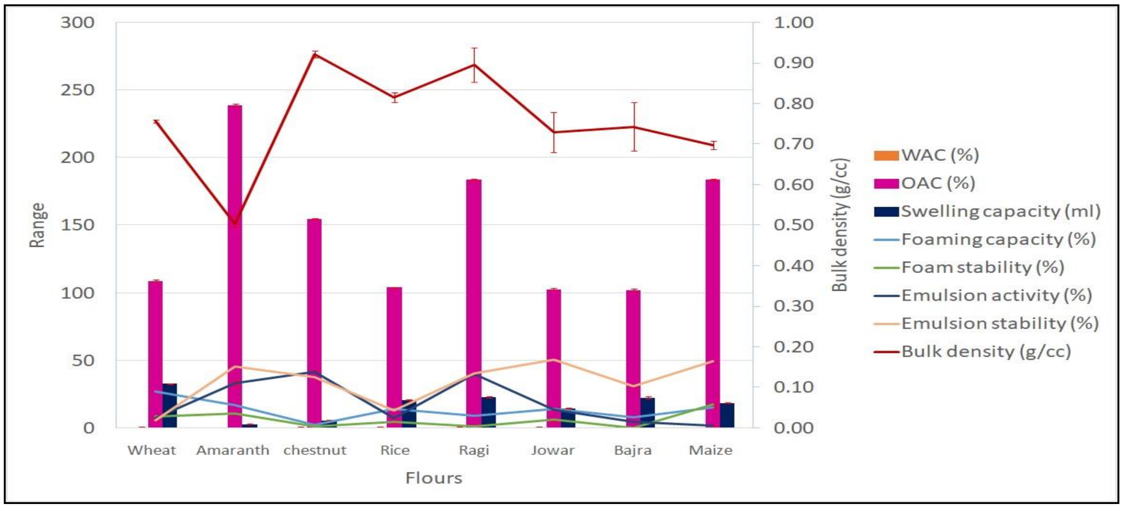

Figure 2: Functional properties of individual flours

while least in ragi flour (341 Kcal). The sodium was found in the range of 0 to 1% with the highest in wheat, amaranth, rice, jowar and corn flour (1%) while others found free from sodium content.

b. Functional properties of flours

The functional properties include swelling capacity, emulsion stability, emulsion activity, oil absorption capacity (OAC), water absorption capacity (WAC), foaming capacity, stability and bulk density of grains powder were studied and described in Table 2 and fig 2.

The Bulk density ranges in 0.503 to 0.922 (g/cc) in which amaranth flour found minimal bulk density as compare to others. Also, it was observed that rice flour had maximal value of bulk density due to small fine particles of rice powder. The WAC of the flour varied from 116 to 262 % among all types of individual flours. Water absorption capacity was found highest in rice (262%) whereas lowest in wheat (116%). OAC of the flours varied between 102 to 239%. The highest OAC was observed in amaranth (239%) and least in maize (102%). The tendency to swell was found in ranged from 3.07 to 32.65 respectively. It was measured highest in wheat (32.65 ml) and lowest in amaranth (3.07 ml). Foaming capacity of flours was observed highest in wheat flour (26.8%) due to depend on protein content and carbohydrate of the wheat flour and least in rice (2.60%). Texture and structure of rice also affected the foam capacity due to hardness among the other flours. The foam stability of the samples was observed 0 to 17.26% with the highest value depicted in chestnut flour (17.26%); this may be due to protein and carbohydrate content whereas 0% in maize flour may be due to its texture which may affect the foam stability. The emulsion activity of the flour varied 1.83 to 41.93% among all the samples with the highest value refers to rice flour (41.93%) and lowest in chestnut flour (1.83%). The emulsion stability of the flour observed from 5.66 to 50.45% highest in bajra and least in wheat. Structure and texture of wheat also affected the emulsion stability among other flours.

The test samples were thoroughly examined and study revealed the range of gluten-free flours, *viz*., bajra, rice, chestnut, amaranth, corn, ragi and jowar; whereas, gluten content was analyzed in the wheat flour. The study was focused on assessment of various highly nutritional flours of traditional Indian cuisine and evaluation of their nutritional value and functional capabilities to determine whether they could have potential to replace wheat flour.

Plate – 1: Grains and their flour test samples

A – Wheat; B – Amaranth; C – Rice; D – Ragi; E – Jowar; F – Bajra; G – Maize; H - Chestnut

4. Conclusion

After evaluation, nutritional as well as functional parameters of various millets, other grains and wheat flour, it is found that though there is a significant difference between the flour of ragi jowar and bajra which was found superior as compare to other flours however, it is also revealed that amaranth and maize flour are also having some potential nutritional capabilities.

These flours are having high nutritional qualities like rude and dietary fibers, carbohydrates, protein, energy etc., which is essential in terms of balanced dietary supplements. As a conclusive remark the combination of ragi, jowar, bajra, amaranth and maize flour is an ideal combination to fulfill dietary requirements. Besides, millets are gluten free which ultimately provides the significant contribution in terms of avoiding side effects of gluten present in the wheat flour. The study helps people make wise dietary decisions and ushers in a paradigm change towards more nutrient-rich and balanced gluten-free options by illuminating the nutritional tapestry of these flours.

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Conflict of Interest

All authors declare that they have no conflicts of interest

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