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Original Research Article

Exploration of Gluten-Free Baked Food Products Incorporated by Germinated Finger (*Eleusine Coracana*) and Pearl (*Pennisetum Glaucum*) Millets: A Therapeutic Approach

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ABSTRACT

The concepts of food consumption are changing from previous to present time. Previous emphasis has been on survival, hunger satisfaction, health maintenance and absence of adverse effects on health and current emphasis is on encouraging the use of nutraceutical foods. It promises to promote better health and well being thus, helping to reduce the risk of chronic diseases such as obesity, diabetes, cardiovascular diseases, celiac diseases and cancer. Millets have nutraceutical properties with cheap in cost. Finger and pearl millets are rich in nutrients, phytochemical and antioxidants but also contained anti-nutrients which can be reduced by germination significantly. Enzyme activities such as amylase, acid and alkaline phosphatase in GFMF and GPMF increased significantly compared to WRFMF and WRPMF. So present study was designed to develop baked food products by using locally available (finger and pearl). Different types of baked foods named Milleti-burger, Veggimillet pizza and Nutric bread were developed and their sensory acceptability and nutrients analysis were done. Sensory evaluation were revealed that GFMF and GPMF incorporated baked foods are earned acceptable mean scores and containing higher percentage of energy, protein, fat, iron and calcium compare to standard.

Key Words: Germination; Burger; Pizza; Bread; Anti-nutrients; Enzymes activities

INTRODUCTION

Millets observed as nutritious and health beneficial food grains and help in management of disorders. Innovative millets processing technologies are helping tool to provide easy-to-handle, ready-to-cook, ready-to-eat, safe products and meals at a commercial scale to feed large populations in urban areas. But, lacks of proper marketing avenues of these crops have also led to their rapid decline in both production and consumption. Millets considered as staple food or minor cereal. Nutritional composition and other health benefits are equal in millets as compare to other cereal such as wheat and rice. Apart from the nutrients, millets also contain substantial amount of phenolic compounds and antioxidants which have health-promoting properties. [1] Millets have nutraceutical properties such as helps in lowering the risk of obesity, high blood pressure, CVD, type2 diabetes, gastrointestinal tract infection, constipation, duodenal and colorectal cancer, [2] anemia and celiac diseases. It is referred to as anti-inflammatory properties and also acts as probiotic food. [3] They help to prevent from anemia and osteoporosis because of the presence of high amount iron (pearl millet) and calcium (finger millet). Presences of magnesium in millets have the ability to reduce the heart attack and migraine. [4] Millet's phenolics may be effective in the prevention of cancer initiation and progression. [5] They are gluten free minor cereal, alkaline in nature and great option for celiac patients. Millets have enzymatic activities due to the presence of alpha, beta and gamma amylases, acid and alkaline phosphatase. Amylases help in managing the quality of many food grains till the end uses. Amylase enzymes break the starch and glycogen into reducing fermentable sugars such as maltose and slow fermentable or non fermentable sugar such as dextrins. Amylases are synthesized in plants during germination of starch rich seeds. It converts insoluble starch to soluble sugars. [6] Acid phosphatase enzyme is hydrolytic enzyme of phosphorus which breakdown the reserve phosphate during seed germination [7] and enhances the phosphorus availability in food stuff.

Millets are cheap source of major and minor nutrients for poorest people. But their utilization is limited due to the presence of anti-nutrients, poor digestibility and low palatability that can be reduced by household food processing methods. An anti-nutritional factor is naturally occurring phosphorus compound such as phytate and phytic acid significantly influences the functional and nutritional properties of foods. Food processing methods helps to make meal more attractive in appearance, consistency, flavor, taste, verities as well as making the food safe and increase shelf life with qualitatively changes in the nutritional value of the food due to decreasing anti-nutrients and enhance the availability of nutrients. Germination process is distinguished by the hydration of tissues and cells and initiate of enzymatic activity which accountable for mobilization of stores for respiration and formation of new cell structures. Germination not only improves the taste but also enriches the nutritive value with increasing protein digestibility, fiber, vitamin B and decreasing the anti-nutrients. [8] Germination improves the mineral availability and bioavailability and in same line reduces anti-nutrients. Finger millet (*Eleusine coracana*) or 'Ragi' belongs to minor cereal and mostly consumed in India and Africa. It is third ranked millet crop in India. It can cultivated easily, have excellent storage properties, rich and cheap source of nutrients, which is higher than rice and equal to wheat. Finger millet is a very good source of micronutrient such as calcium, iron, phosphorous, zinc and potassium, which could be alleviate malnutrition in the developing countries. [9] Pearl millet (*Pennisetum glaucum*) or 'Bajra' is a staple food in Asia and Africa produce in arid and semi arid land. It is fourth ranked most tropical crop in world. It is good source of nutrient and micronutrient especially rich in iron among all cereals. [10] Pearl millet has high level of calcium, iron, zinc, lipids, and amino acids [11] such as lysine, tryptophan, threonine and fatty acid like omega-9, omega-6 and omega-3 fatty acids. Here we are prepared baked food products such as Milleti-burger, Veggimillet pizza and Nutric bread incorporated by germinated finger and pearl millets to concern therapeutic potential of millets. Baked food products can be good alternative in different diseases conditions such as Obesity, diabetes, cardiovascular diseases, celiac patients etc. It is for convenience, pleasure and healthy and consumed to all age groups.

Adolescents love to eat fast foods which are maida based food consumed all around the world. Milleti-burger is an attractive and tasty food and consumed any time when children feel hungry. Milleti-burger is improvised form of burger incorporated by GFMF (germinated finger millet flour) and GPMF (germinated pearl millet flour) with other ingredients (peas, potato, gingelly seeds and peanut butter) to improve nutrients quality and quantity of meal. Milleti-Burger is rich in energy, protein, calcium, iron and vitamins to help in optimum growth of bone and future health status. Gingelly seeds are rich in protein, essential fatty acid and minerals. Peas are good source of vitamins and essential minerals. Potato is excellent source of carbohydrates. Pizza is generally rich in energy but deficient in other essential nutrients. Thus, to improve nutritive value of Pizza, GFMF and GPMF were incorporated to enhance protein, calcium and iron. While preparing Veggimillet pizza, add sesame, flaxseeds and olive oil. Some vegetables such as capsicum and onion were used for topping to improve vitamins and minerals. Flaxseeds are high in fiber, omega-3 fatty acids and lignans (antioxidant). Cheese gives plentiful supply of vitamin B_{12}, A, K_2, selenium, phosphorus, and sodium. Capsicum is rich source of beta-carotene, vitamin C and onion contains vitamin B_6, C, folate, manganese, potassium and antioxidant (quercetin). Olive oil is loaded with vitamin E and monounsaturated fats help in minimize cancer risk and lowering bad cholesterol respectively. Nutric bread is made from wheat flour, GFMF, GPMF, soya flour, gingelly seeds and carrot. Soya flour provides advisable amount of protein, dietary fiber, essential minerals and good amount of thiamine, folate, copper and iron. Carrot is rich in β-carotene and antioxidants, preventing and curing of diseases. GFMF and GPMF have good amount of calcium and iron, rich in energy. Yeast is good sources of protein, vitamins and minerals (magnesium, copper and manganese). This Nutric bread fulfills the requirement of nutritional need in body, and appropriate for celiac patients.

MATERIALS AND METHODS

Selection and procurement of finger and pearl millets

Finger and pearl millets were purchased from local market of Jaipur, Rajasthan.

Preparation of processed forms

Whole raw finger millet flour (WRFMF) and Whole raw pearl millet flour (WRPMF): Finger and pearl millets were thoroughly cleaned, remove foreign material and dirt. Thereafter, they were sundried and ground into fine flour or powder in a mixer and stored separately.

Germinated finger millet flour (GFMF) and Germinated pearl millet flour (GPMF): One portion of finger and pearl millets was soaked overnight separately. Next day, water was drained and wrapped of seeds in a muslin cloth and hung in a humid atmosphere for germination. This germination process was conducted for 48 hours and both millets were sundried properly to make moisture free. Germinated seeds were ground in a mixer and stored separately in container for analysis.

Finger and pearl millets + water
↓
Soaked overnight separately
↓
Water drained and wrapped in muslin cloth
↓
Keep for 48 hours
↓
Sun drying
↓
Ground and make powder form
↓
Stored in air tight bag

Figure1: Germination of finger and pearl millets

Nutrients analysis

For analysis of chemical composition, various versions of samples were prepared. Moisture [12] is estimated by drying up the sample in an air oven at 100-125°C till the weight becomes constant. Ash is estimated when sample is burned to high temperature (600°C) for 4-5 hours in muffle furnace, organic matter getting converted into gases but leaving mineral elements and weighted as mineral ash. Fat is estimated as crude ether extract of the dry material. Weighed the moisture free samples and transferred them to the thimble. Placed the thimble in a soxlet apparatus and extracted with petroleum ether. After extraction, solvent ether was evaporated and residue further dried in the oven, cooled and finally weighed and crude fibre is estimated by subjecting the foodstuff acted upon by a dilute mineral acid and alkali. [13] Protein [14] based on organic nitrogen when digested with sulphuric acid is converted into ammonium sulphate in the presence of catalyst. By making the solution alkaline, liberated ammonia is distilled into a known volume of standard acid, which is titrated. Total carbohydrate was calculated by difference. It is by subtracting from 100 the sum of the values (per 100 g) for moisture, protein, fat, ash and crude fibre. [13] Calcium is precipitated as oxalates. The precipitate is titrated with standard $KMnO_4$ in the presence of dil. HCL following redox reaction in which $KMnO_4$ act as a self indicator. [15] Iron [13] is estimated spectrophotometrically making use of the fact that ferric iron gives a blood red color with potassium thiocyanate. Suitable aliquot of the solution is taken and treated with molybdic acid to produce phosphomolybdic acid, which is reduced by the addition of 1 amino, 2 naptho1, 4-sulfonic acid (ANSA) and measured the blue color and calculated phosphorus. [15] Vitamin C (L-ascorbic acid) gets oxidized to it's dehydro form. Therefore, vitamin C in 6% metaphosphoric acid is stabilized and titrates with 2, 6, dichlorophenol indophenol solution. Oxidized form of this dye has a red color in acidic medium and blue color in alkaline medium. [14]

Enzymes activities [15]

Amylase activity is based on estimating the extent of starch hydrolysis by the enzyme source. Starch iodine reaction is made use of, in the colorimetric estimation of unhydrolysed starch. 1 unit = 1 mg of starch hydrolyzed by 1 g of food sample in 30 minutes. Alkaline phosphatase is estimated by disodium phenyl phosphate is hydrolyzed by the enzyme into sodium phosphate and phenol in the sample. Phenol liberated makes colored derivatives with 4 amino antipyrine-ferricyanide, for extinction measurement in a colorimeter at 520 nm. One king Armstrong unit refers to the activity of enzyme that liberates 1 mg of phenol at 37^o C. Acid phosphatase is based on disodium phenyl phosphate is hydrolyzed by the enzyme present in the sample, into sodium phosphate and phenol. Phenol librated makes colored derivatives with 4 amino antipyrine- ferricyanide, and extinction measurement in a colorimeter at 530 nm. One King Armstrong unit refers to the activity of enzyme that liberates 1 mg of phenol at 37^o C.

Anti-nutrient analysis

Phytic acid [16] is based on the determination of pink color complex precipitate as ferric ions complexed with phytate at pH1-2 can't react with thiocyanate ion and the phytate phosphorus content calculated from this value assuming a constant 4 Fe: 6P molecular ratios in the precipitate. Graph of standard was plotted and results were expressed as mg phytic acid/100g dry wt. Oxalic acid [14] is precipitated as oxalate and is titrated with standard $KMnO_4$. Trypsin enzymatic activity is assayed using casein as substrate. Inhibition of this activity is measured in the extract [17] absorbance was plotted against the volume of extract. One trypsin unit (TU) is defines as an increase of 0.01 absorbance units at 20 minutes per 10 ml of the reaction mixture. Trypsin inhibitor is defined as the number of trypsin units inhibited (TIU).

Product development and its acceptability evaluation

Food products are prepared by incorporation of GFMF and GPMF food products named Milleti-burger, Veggimillet pizza and Nutric bread are developed by incorporating at level of 10, 20 and 30% in variants A, variants B and variants C respectively and the last variants are standards which are prepared without incorporation of millets.

Sensory evaluation of baked food products was done by using of sensory tools named Nine Point Hedonic Test. [18] In this method, the developed foods were placed near to twenty panelists to evaluate for acceptability at nine point hedonic test. The panelists were judged the acceptability and measure the pleasurable and unpleasurable experiences ranging from 'like extremely' to 'dislike extremely' of the food products. The Performa was carried out 1 to 9 scores, the members were asked to give score to the new foods on the bases of hedonic scale for appearance, color, texture, taste, flavor, after taste and overall acceptability. Performa were collected and resulted were documented.

Nutrient analysis of baked food products

Nutrient analysis of developed baked food products (Millet-burger, Veggimillet pizza and Nutric bread) such as energy, protein, fat, carbohydrate, iron and calcium are analyzed using above mentioned methods.

Statistical analysis

Mean (X), [19] standard Deviation (SD) and student's t-test, [20] The significant difference was based on as P ≥0.05 non-significance difference, P ≤0.05 significance difference. P ≥0.05 Non-significance difference, P ≤0.05 Significance difference.

RESULTS AND DISCUSSION

Nutrients analyses of all versions of finger and pearl millets have been done and results are shown in Table 1. It is found that the moisture content for WRFMF, GFMF are 13.1±0.10, 16.2±0.25 (g/100g) and for WRPMF, GPMF are 12.4±0.40, 15.0±0.50 (g/100g) respectively. Significant difference has been found in moisture content of GFMF, when compared with WRFMF and also in GPMF compare with WRPMF. It shows that during germination moisture content is increased significantly. Germination caused moisture content increased significantly in GFMF and GPMF similar to that investigated by other studies. [21] Total ash content for WRFMF, GFMF is 2.8±0.17, 2.7±0.10 and for WRPMF, GPMF are 2.3±0.10, 2.2±0.20. After processing, non- significant difference is found in ash content for all versions GFMF and GPMF when compare with WRFMF and WRPMF respectively. Ash content was observed reduce in germination insignificantly. [22] Fat content for different versions are - WRFMF: 1.3±0.20, GFMF; 2.0±0.20, WRPMF; 5.0±1.00, GPMF; 5.9±0.20. It is found that fat content after germination increases significantly. Germination caused fat content to increase significantly in pearl millet. [23] Finger and pearl millets contain reasonable crude fiber which makes it low energy food, noticeable protein food stuff rich in fiber. For WRFMF, GFMF, WRPMF and GPMF, the crude fiber contents are 3.5±0.10, 4.5±0.10, 2.1±0.05 and 2.8±0.10 respectively. The crude fiber content is increased significantly in germinated samples. Millets are good source of protein and the protein content of different variants are 7.1±0.20 (g/100g) in WRFMF, 8.7±0.26 (g/100g), in GFMF, 11.1±1.10 (g/100g) in WRPMF and 14.4±1.08 (g/100g) in GPMF. It has been seen that there is significant increase in protein content of all germinated samples compared to native samples. As germination time increase from 8 to 4 h, the protein content was in the range of 14-18.7%. [24] Carbohydrate content in all samples such as in WRFMF, GFMF, WRPMF and GPMF is 71.8±0.20, 69.2±0.40, 67.5±0.36 and 64.7±0.35 (g/100g) respectively. It has been registered that carbohydrate content significantly decreases during germination. This result was also agreement with [25] for foxtail millet's germination.

Mineral analyses and Vitamin 'C' estimation

Mineral content in all versions of processed finger and pearl millets demonstrates in Table 2. The calcium content of WRFMF, GFMF, WRPMF and GPMF have been found as 342.4±1.36, 359.6±2.05, 41.2±0.57 and 51.2±2.90 (mg/100g) respectively. Mineral analysis of processed forms of all versions reveals that calcium content increased significantly during germination. Iron contents for WRFMF, GFMF, WRPMF and GPMF are 3.7±0.06, 4.5±0.05, 8.0±1.20, 8.9±0.50, (mg/100g) respectively. There is significantly increase in iron content of all versions; GFMF and GPMF during germination. Due to decreases of oxalic acid during sprouting, correspondingly increases calcium content in finger millet because oxalic acid is known to interfere with calcium absorption. [22] Similar result was observed for germinated maize as an 11.4% increase in iron content. [26] A similar loss of phosphorus content in germinated samples also investigated in other studies. [27] Phosphorous content of all versions i.e. WRFMF, GFMF, WRPMF and GPMF are 280.1±1.23, 272.2±2.00, 298.3±1.00 and 281.1±1.30 (mg/100g) respectively. Phosphorus content decreased significantly during germination. Vitamin 'C' content in all versions of processed millets demonstrates in Table 2.Vitamin 'C' estimation of all versions (WRFMF, GFMF, WRPMF and GPMF) has revealed that germination process enhances vitamin C content significantly; 0.04±0.01 (mg/100g) - WRFMF, 0.06±0.01 (mg/100g) - GFMF, 0.01±0.00 (mg/100g) - WRPMF, 0.03±0.01 (mg/100g) – GPMF. Results were same in other studies. [28]

Table 1: Mean value of proximate in raw and germinated finger and pearl millets (g/100g)

Parameters	WRFMF	WRPMF	GFMF	GPMF
Moisture	13.1±0.10	12.4±0.40	16.2±0.25^{s}	15.0±0.50^{s}
Ash	2.8±0.17	2.3±0.10	2.7±0.10^{ns}	2.2±0.20^{ns}
Fat	1.3±0.20	5.0±1.00	2.0±0.20^{s}	5.9±0.20^{s}
Crude Fiber	3.5±0.10	2.1±0.05	4.5±0.10^{s}	2.8±0.10^{s}
Protein	7.1±0.20	11.1±1.10	8.7±0.26^{s}	14.4±1.08^{s}
CHO	71.8±0.20	67.5±0.36	69.2±0.40^{s}	64.7±0.35^{s}

^{s} Significant, ^{ns} Non-significant, WRFMF- Whole raw finger millet flour, WRPMF- Whole raw pearl millet flour, GFMF- Germinated finger millet flour, GPMF- Germinated pearl millet flour, PFMF- Popped finger millet flour, PPMF- Popped pearl millet flour.

Table 2: Mean level of mineral and vitamin C in raw and germinated finger and pearl millets (mg/100g)

Parameters	WRFMF	WRPMF	GFMF	GPMF
Calcium	342.4±1.36	41.2±0.57	359.6±2.05^{s}	51.2±2.90^{s}
Iron	3.7±0.06	8.0±1.20	4.5±0.05^{s}	8.9±0.50^{s}
Phosphorus	280.1±1.23	298.3±1.00	272.2±2.00^{s}	281.1±1.30^{s}
Vitamin C	0.04±0.01	0.01±0.00	0.06±0.01^{s}	0.03±0.01^{s}

^{s} Significant, ^{ns} Non-significant, WRFMF- Whole raw finger millet flour, WRPMF- Whole raw pearl millet flour, GFMF- Germinated finger millet flour, GPMF- Germinated pearl millet flour, PFMF- Popped finger millet flour, PPMF- Popped pearl millet flour.

Enzyme activities of all versions of finger and pearl millets depicts in figure 2. It is found that amylase, acid and alkaline phosphatase activity in WRFMF is amounting to 38.5±1.20, 15.5±2.20, 9.3±0.05 (U/g) and in WRPMF amounting to 22.6±1.80, 1.75±0.30, 1.38±0.10 (U/g) respectively. Enzyme activity value of GFMF and GPMF reveals that amylase, acid and alkaline phosphatase activities have been increased significantly to 604.6±5.30, 80.3±1.30, 12.9±1.10 and to 359.9±3.80, 8.7±1.40, 208.9±2.50 (U/g) respectively during germination. There is an increase in alpha amylase activity during germination which was used by growing embryo and break down complex carbohydrate to simple. [29]

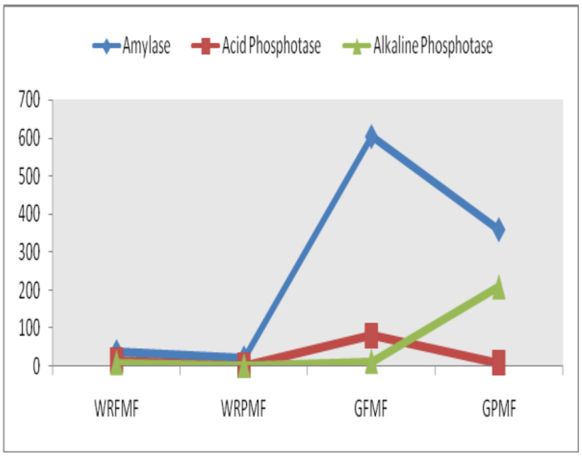


Figure 2: Graphical presentation of enzymes activities in raw and germinated finger and pearl millets

Anti-nutrient content in all versions of finger and pearl millets shows in Table 3. Phytic acid for WRFMF and WRPMF are 851.4±1.60 and 858.6±2.60 (mg/100g). After germination, it has been found as 338.4±1.30 (mg/100g) in GFMF and 397.4±1.54 (mg/100g) in GPMF. Phytic acid is significantly decreases in germination process. Similar results were found in another study. [30] Whereas, oxalic acid content for all version are WRFMF; 45.8±3.50, WRPMF; 21.2±1.05, GFMF; 29.8±2.06, GPMF; 15.1±3.90, (mg/100g). Oxalic acid is significantly decreased during germination process. While in context of trypsin inhibitor activity, processing has led to the decreasing trends. Trypsin inhibitor activity among WRFMF, GFMF, WRPMF and GPMF has stood at 4188±8.00, 2001±5.10, 7190±3.40 and 5732±3.30 (U/g). Therefore, indicating significant decreases the level of trypsin inhibitor activity in germination. It is observed that anti-nutrients such as phytic acid, oxalic acid and trypsin inhibitor activity decreases significantly during germination. [31]

Table 3: Mean level of anti-nutrient in raw and germinated finger and pearl millets

Parameters	WRFMF	WRPMF	GFMF	GPMF
Phytic acid (mg/100g)	851.4±1.60	858.6±2.60	338.4±1.30^s	397.4±1.54^s
Oxalic acid (mg/100g)	45.8±3.50	21.2±1.05	29.8±2.06^s	15.1±3.90^s
Trypsin inhibitor activity (U/g)*	4188±8.00	7190±3.40	2001±5.10^s	5732±3.30^s

***One unit (U) of the inhibitor activity was expressed as decrease by one unit of absorbance measured at 620 nm in 20 min.**
^{s} Significant, ^{ns} Non-significant

Sensory evaluation of developed baked food products

Milleti-Burger is a tasty, handy, nutritious meal. Milleti-Burger is prepared by incorporation of GFMF and GPMF each at 10, 20 and 30% proportions in the three variants respectively. Acceptability evaluation scores of Milleti-Burger are shown in Table 4. From the scores of standard and all variants for each attributes, it is observed that standard is better as compared to the other variants of finger and pearl millets with an overall acceptability score of 8.6±0.68, variant A is most acceptable with an overall acceptability score of 8.0±0.97 among all variants. Variant C is least acceptable with an overall acceptability score of 7.2±0.91. There is a significant difference (P≤0.05) between standard and variant A. Standard got the highest mean score in terms of appearance and followed by variants A, B, C. Color wise, standard has received first rank and variant A is the second choice of panel members. Variants B and C followed the variant A. In terms of texture, standard got the highest mean scores followed by variant B, A and C respectively. Taste attribute follows the same pattern as texture. Standard has been liked most by the panel members followed by variants B, A and C for taste. Panel members like the flavor of standard the most. After standard, the sequence of preference for flavor is variant B, A and C. After taste attribute of the standard is liked most followed by variant A, B and C. Foxtail millet incorporated bread at 10, 30 and 50% level for studying proximate composition and sensory evaluation using nine point hedonic scale. Sensory evaluation indicated that overall acceptability scored 7.15 for 50% incorporated foxtail millet compare to control (7.73). Foxtail millet enriched bread (50:50) contained higher amount of protein (12.67 g/100g) and total mineral content (1.48 g/100) than control. Millet-burger is richer in energy, iron and calcium compare to standard. [32]

Whole raw finger millet flour, WRPMF- Whole raw pearl millet flour, GFMF- Germinated finger millet flour, GPMF- Germinated pearl millet flour,

Veggimilet Pizzas are prepared by incorporating GFMF and GPMF each at 10, 20 and 30% levels in three variants respectively. Acceptability evaluation scores of Veggimillet Pizzas are shown in Table 6. From the scores of standard and all other variants for each attribute, it is clear that standard is most acceptable with an overall acceptability score of 8.2±0.78 and among all the variants, variant A is most acceptable with an overall acceptability score of 7.8±0.48, variant C is third choice with an overall acceptability score of 7.8±0.83 and Variant B is least acceptable with an overall acceptability score of 7.6±1.04. There is a significant difference (P≤0.05) between standard and variant A. Standard is the best in terms of appearance. Among the variants, variant C is the most preferred by the panel members followed by variant B and A. Standard has been given the top rank in terms of color. Variant B and C has received equal scores and stood at second preference followed by variant A. In terms of texture, standard is most acceptable followed by Variant C, variant B and variant A. Standard stood first in terms of taste among all variants. Variant A is most acceptable among all variants. Variant C is more acceptable compare to variant B. Flavor wise, standard is found to be the most acceptable. Variant A, C and B got second, third and fourth position respectively. Panel members have selected standard as best in terms of after taste attribute. Variant A and variant C are ranked second and third respectively, whereas variant B is least acceptable. Veggimillet pizza is more nutritious compare to control in terms of protein, fat and mineral (iron and calcium).

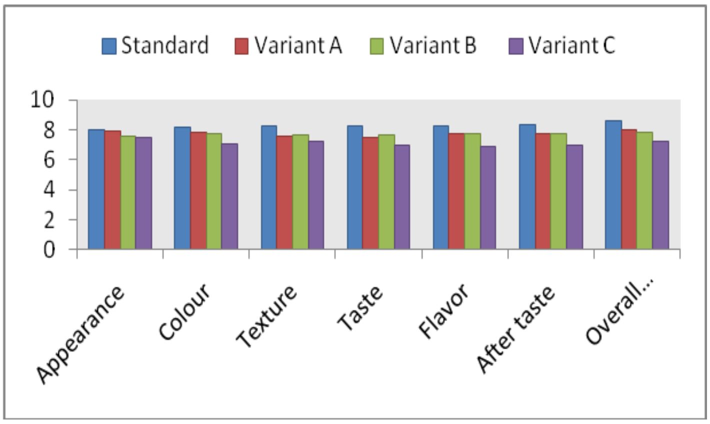
Table 4: Mean scores of developed different variants of Milleti-burger

Attribute	Standard	Variant A	Variant B	Variant C
Appearance	8.00±0.91	7.95±0.75	7.6±0.88	7.5±0.94
Colour	8.15±0.58	7.85±0.87	7.8±0.83	7.1±1.02
Texture	8.25±0.63	7.55±0.82	7.65±0.98	7.2±1.15
Taste	8.30±0.65	7.50±0.88	7.7±0.97	7.0±0.91
Flavor	8.25±0.85	7.75±0.78	7.8±0.89	6.9±0.85
After taste	8.35±0.67	7.8±1.05	7.75±0.91	6.95±0.88
Overall acceptability	8.6±0.68	8.0±0.97^{s}	7.85±1.03	7.25±0.91

^{s} **Significant,** ^{ns} **Non-significa**

Table 5: Nutrients estimation of Milleti-burger

Variants	Energy (Kcal)	Protein (g)	Fat (g)	Carbohydrate (g)	Iron (mg)	Calcium (mg)
Standard	352.71	11.575	9.38	55.553	3.5266	107.96
Variant A	353.41	11.471	9.903	55.033	3.8866	139.44
Variant B	354.11	11.367	10.426	54.513	4.2466	170.92
Variant C	354.81	11.263	10.949	53.993	4.6066	202.40



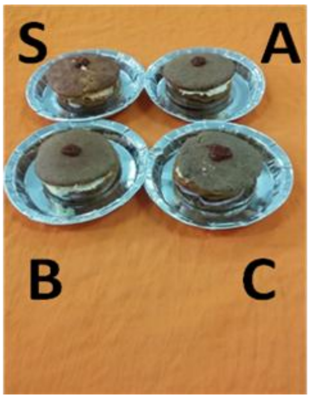


Figure 3: Acceptability evaluation of Milleti-burger incorporated by GFMF and GPMF

Table 6: Mean scores of developed different variants of Veggimillet pizza

Attribute	Standard	Variant A	Variant B	Variant C
Appearance	8.15±0.87	7.35±0.87	7.55±0.94	7.95±1.05
Colour	8.2±0.89	7.25±0.85	7.4±0.68	7.4±0.88
Texture	8.15±0.67	7.15±0.87	7.3±0.73	7.35±0.58
Taste	8.2±0.89	7.75±0.78	7.15±1.03	7.3±1.07
Flavor	7.95±0.82	7.15±0.58	7.05±1.39	7.1±1.02
After taste	8.2±1.10	7.8±0.76	7.15±1.34	7.3±1.12
Overall acceptability	8.25±0.78	7.85±0.48^{s}	7.6±1.04	7.8±0.83

^{s} **Significant,** ^{ns} **Non-significant**

Table 7: Nutrients estimation of Veggimillet pizza

Variants	Energy (Kcal)	Protein (g)	Fat (g)	Carbohydrate (g)	Iron (mg)	Calcium (mg)
Standard	366	11.251	13.177	51	2.34245	147.84
Variant A	365	11.367	13.86	49	3.14245	184.32
Variant B	365	11.483	14.543	48	3.94245	220.8
Variant C	364	11.599	15.226	46	4.74245	257.28

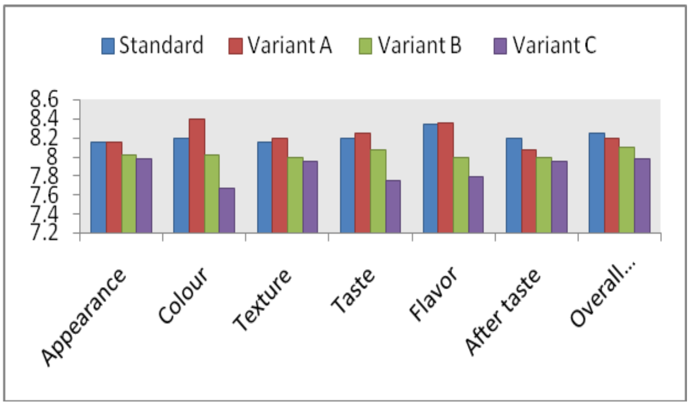


Figure 4: Acceptability evaluation of Veggimillet pizza incorporated by GFMF and GPMF

Nutric Bread is a nutritious, handy, easily eaten at any time of the day. It is developed by incorporating GFMF and GPMF each in different proportions such as in 10, 20 and 30% in the three variants. Acceptability evaluation scores of Nutric Bread are shown in Table 8. From the scores of standard and all variants of each attributes, it is clear that standard is most acceptable with an overall acceptability score of 8.1±1.22 among all the variants, variant A is most acceptable with an overall acceptability score of 7.5±1.00 and variant C is least acceptability with an overall acceptability score of 6.8±1.39 among the variants. There is a significant difference (P≤0.05) between standard and variant A. In terms of appearance, standard is highly acceptable followed by variant A, B and C. Color follow the same pattern as appearance. Standard likes the most and followed by variant A, B, C. Highest mean score for texture is observed for standard. Variant A has become the second choice of panel members. Variant B and C followed variant A. Standard has got the highest mean score in terms of taste. Variant A and B scores same mean values and followed by variant C. Standard is the best in the terms of flavor too followed by variant A, variant B and variant C. Standard is most acceptable in after taste attribute also. Variant A, B and C have been chosen next to standard by the panel members. One study indicated that up to 30 % incorporation of finger millet blended with wheat flour not affected bread's sensory qualities. [33] Nutric bread is delicious, nutritious with good source of macro and micronutrients compare to standard

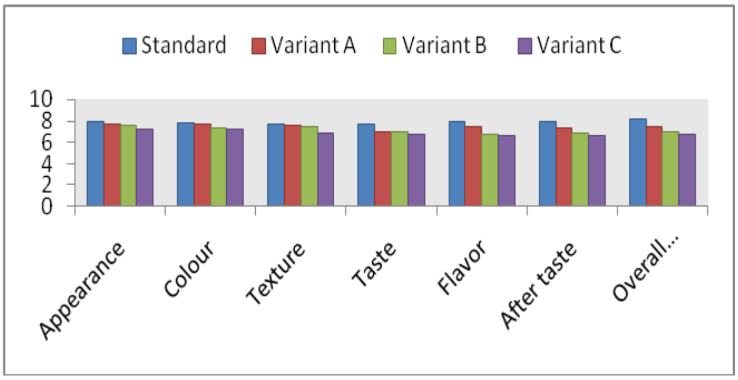
Table 8: Mean scores of developed different variants of Veggimillet pizza

Attribute	Standard	Variant A	Variant B	Variant C
Appearance	7.95±1.19	7.7±0.73	7.6±1.42	7.2±1.32
Colour	7.8±1.23	7.7±1.08	7.3±1.45	7.25±1.20
Texture	7.7±1.12	7.65±1.18	7.45±1.09	6.85±1.46
Taste	7.75±1.06	7.0±1.21	7.0±1.62	6.7±2.10
Flavor	7.95±1.23	7.5±0.88	6.7±1.38	6.65±1.38
After taste	7.9±0.85	7.35±0.87	6.85±1.30	6.6±1.60
Overall acceptability	8.15±1.22	7.5±1.00^{s}	6.95±1.43	6.8±1.39

^{s} **Significant,** ^{ns} **Non-significant**

Table 9: Nutrients estimation of Nutric bread

Variants	Energy (Kcal)	Protein (g)	Fat (g)	Carbohydrate (g)	Iron (mg)	Calcium (mg)
Standard	378.67	16.045	9.011	58.389	4.9074	146.5
Variant A	379.37	15.941	9.534	57.869	5.2674	177.98
Variant B	380.07	15.837	10.057	57.349	5.6274	209.46
Variant C	380.77	15.733	10.58	56.829	5.9874	240.94



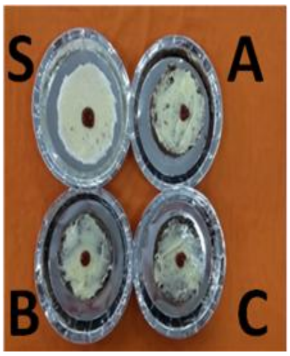


Figure 5: Acceptability evaluation of Veggimillet pizza incorporated by GFMF and GPMF

CONCLUSION

Cultivation of millets and promotion for its utilization will be one of the successful potential approaches for improving the nutritional status and human health specifically in financially weaker population. Millets are not only good source of many nutrients such as protein, fiber, vitamin B, calcium, iron, potassium, magnesium and zinc but also gluten-free and have low Glycemic index (GI). Millets are excellent source of starch that benefit to making it high-energy foods. Millets can be cooked as different variety of food and have potential to replace wheat and rice. Finger and pearl millets have potential to fight deep rooted malnutrition. Apart from these, finger and pearl millets have important nutraceutical and therapeutical values such as anti-diabetic, anti-hyperlipidemic, anti-allergic for gluten sensitive patients, anti-carcinogenic, anti-cataractogenesis, anti-inflammatory, anti-lithiatic, anti-ageing, nephroprotective and help in wound healing, strengthening nervous system, increasing hemoglobin level. Millets also contained anti-nutrients which can be reduced by germination and enhance the potential of therapeutic nature. All age groups loved to eat baked food products. Developments of baked foods by incorporation of GFMF and GPMF have sensory acceptability and rich in nutrients and having therapeutic potential. Milleti-burger, Veggimillet pizza and Nutri bread are ready to eat, healthy, nutritious and attractive food.

REFERENCES

1. Sarita and Singh, E. Potential of Millets: Nutrients Composition and Health Benefits. Journal of Scientific and Innovative Research. 2016; 5(2):46-50
2. Radhouane, L. Allelopathic effect of pearl millet (Pennisetum Glaucon) seeds on seedlings growth of three cereals. International journal of Innovation and Scientific Research. 2008; 6:18-24.
3. Vanisha, S., Nambiar, Dhaduk, Sareen, N., Shahu, T. and Desai, R. Potential functional implications of Pearl Millet (Pennisetum Glacum) in Health and Disease. Journal of Applied Pharmaceutical Science. 2011; 01(10):62-67.
4. Ocheme, O. B. and Chinma, C. E. Soaking and germination on some physiochemical properties of millet flour for porridge production. Journal of food technology. 2008; 6(5):185-188.
5. Chandrasekara, A. and Shahidi, F.. Antiproliferative Potential and DNA Scission Inhibitory Activity of Phenolics from Whole Millet Grains. Journal of Functional Foods. 2011c; 3:159–170.
6. Pande, A., Singh, S., Samad, J., Saurabh, K. and Haider, Z. A. Studies on potential of finger millet (Eleusine coracana gaertn. L.) amylases for industrial applications. The international journal of Biotechnology. 2008; 4(4):20-29.
7. Kulkarni, S. S. and Chavan, P. D. Influence of lactic acid on seed germination of finger millet (Eleusine coracana gaertn.). International Journal of Applied Biology and Pharmaceutical Technology. 1969; 3(4):242-247.
8. Varma, V and Patel, S. Value added products from nutri-cereals: Finger millet

(Eleusine coracana). Emirates Journal Food Agriculture. 2013; 25(3):169-176.
9. Shashi, B. K., Sharan, S., Hittalamani, S., Shankar, A. G., and Nagarathna, T. K. Micronutrient composition, antinutritional factors and bioaccessibility of iron in different finger millet (Eleusine coracana) genotypes. Karnataka Journal of Agricultural Sciences. 2007; 20(3):583-585.
10. Adam, I. A., Abdalla, A. A., Khalid, A. I. and El-Tinayl, A. H. Effect of traditional processing on phosphorus content and some antinutritional factors of pearl millet (Pennisetum Glaucan L.). Research Journal of agriculture and Biological science. 2010; 6(3):176-184.
11. Sade, F. O. Proximate, antinutritional factors and functional properties of processed pearl millet (Pennisetum glaucum). Journal of Food Technology. 2009; 7(3):92-97.
12. AOAC. Association of Official Analytical Chemists: Official Methods Analysis (13th ed.). Washington, DC. 2010; 376-384.
13. Raghuramulu, N., Nair, K. M., Kalyanasundaram, S. A Manual of Laboratory Techniques. 3rd Edn. National Institute of Nutrition, India. 2003.
14. Raghuramulu, N., Madhvan, K. M. and Kalyanasundaram, S. A manual of laboratory Techniques (2nd Ed.). Hyderabad: NIN press. 2008.
15. Sharma, S. Experiments and Techniques in Biochemistry. Galgotia Publication. New Delhi. 2007; 55-59.
16. Davies, N. T. and Reid, H. An evaluation of phytate, zinc, copper, iron and availability from soy based textured vegetable protein meat substitutes or meat extruders. British Journal of Nutrition. 1979; 41:579.
17. Kakade, M. L., Simm, N. and Liener, I. E. An evaluation of natural vs synthetic substrates for measuring the antitryptic activity of soyabean samples. Cereal Chemistry. 1969; 46:518-523.
18. Avantina, S. Textbook of Food Science and Technology. 2010.
19. Gupta, S. P. Statistical Methods: Central Value (37th Ed.). New Delhi: Sultan chand and sons. 2004.
20. Steel, R. G. D., and Torrie, J. H. Principles and Procedures of Statistics. New York: McGraw Hill Book Co. Inc. 1980.
21. Ravi, U., Menon, L., Padmini, K. and Sangeetha, V. Impact of germination on oligosaccharide content in select Asian Indian minor millets. Agricultural Science digest. 2011; 31(1):14-19.
22. Pandhre, G. R., Satwase, A. N. and Hashmi, S. I. Studies on drying characteristics and nutritional composition of sprouted wheat and finger millets. International journal of current research. 2008; 3(7):218-221.
23. Maneemegalai, S. and Nandakumar, S. Biochemical studies on the germinated seed of Vigna radiata (L.) R. Wilczek, Vigna mungo (L.) Hepper and Pennisetum typhoides (Burm f.) Stapf and C. E. Hub. International journal of Agricultural research. 2016; 6:601-606.
24. Swami, S. B., Thakor, N. J. and Gurav, H. S. Effect of soaking and malting on finger millet (Eleusine Coracane) grain. Agric. Eng. Int: CIGR Journal. . 2013; 15(1):194-200.
25. Coulibaly, A. and Chen, J. Evaluation of energetic compounds, antioxidant capacity, some vitamins and mineral, phytase and amylase activity during the germination of foxtail millet. American journal of food technology. 2011; 6:40-51.
26. Mihafu, F., Laswai, H. S., Gichuhi, P., Mwanyika, S. and Bovell-Benjamin, A. C. Influence of soaking and germination on the iron, phytate and phenolic contents of maize used for complementary feeding in rural Tanzania. International Journal of Nutrition and Food Sciences. 2017; 6(2):111-117.
27. Sokrab, A. M., Isam A., Ahmed, M. and Babiker, E. E. Effect of germination on antinutritional factors, total, and extractable minerals of high and low phytate corn (Zea mays L.) genotypes. Journal of the Saudi Society of Agricultural Sciences. 2012; 11:123–128.
28. Proietti, S., Moscatello, S., Famiani, F. and Batistelli, A. Increase of ascorbic acid content and nutritional quality in spinach leaves during physiological acclimation to low temperature. Plant Physiology and Biochemistry. 2008; 47:717-723.
29. Onwuka, C.F., Ikewuchi, C. C., Ikewuchi, C. J. and Ayalogu, O. E. Investigation on the effect of germination on the proximate composition of African Yan bean (Sphenostylis stenocarpa Hochst ex A Rich) and fluted Pumpkin (Telferia occidentalis).

Journal of Applied Sciences and Environmental Management. 2008; 13:59-61.
30. Tiwari, A., Jha, S. K., Pal, R. K., Sethi, S. and Krishan, L. Effect of pre-milling treatments on storage stability of pearl millet flour. Journal of Food Processing and Preservation. 2013; 38:1215–1223.
31. Kumar, S. I., Babu, C. G., Reddy, V. C. and Swathi, B. Anti-nutritional factors in finger Millet. Journal of Nutrition and Food Sciences. 2016; 6(3):1-2.
32. Ballolli, U., Malagi, U., Yenagi, N., Orsat, V. and Gariepy, Y. Indian development and quality evaluation of foxtail millet [Setaria italica (L.)] incorporated breads. Karnataka journal of Agriculture science. 2010; 27(1):52-55.
33. Beswa, D., Kock, S. and Siwela, M. Wheat-finger millet-assessment of the feasibility of using a wheat finger millet composite flour for bread making", Lap Lambert Academic Publishing. 2010.

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