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Development of millet milk beverage using cooking technique for enhanced nutrition

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ABSTRACT

Millets especially minor millets gains value in the market by way of converting into value added products that otherwise fetches low value in the domestic market hence value added products is a must in millets and one such is millet based milk and its nutritional significance that combined with other grains or legumes or oilseeds fetches a balanced nutritional diet for all stages of growth in human beings as well as diseased and age old related problems. Present study attempts to develop plant based milk from the underutilized nutricereals, the millets. Different combination of millets *viz*. S1, foxtail and little, S2, proso and little, S3, bajra and proso, S4, sorghum and foxtail, S5, foxtail and proso, S6, sorghum and little, S7. sorghum and ragi, S8, ragi and little, S9, bajra and little, S10, bajra and ragi, S11, ragi and proso, S12 ragi and foxtail, S13, sorghum and bajra, S14, sorghum and proso and S15, bajra and foxtail millet were used in the study. 50g of the above mentioned millet combinations were taken, soaked overnight, cooked, grinded and the milk was extracted. The pH of the extract ranged between 4.75-5.76 with minimum value in S9, maximum in S8. The range of total soluble solids was 7.18-9.46%. The density of millet milk ranged between 0.72-0.95g/cc. The dehydrated milk milk powder was evaluated for nutritional parameters, the fat content as determined by soxhlet extraction ranged from 0.40 -1.40% and the protein content ranged from 9.54-14.22%. The ash content ranged from 0.67-1.87%. The iron content varied from 35.49 to 86.14 mg/100g and the zinc content ranged between 18.78 to 33.99 mg/100g. The study shows that millet based milk can be used to increase diversity in millet based diets. Moreover, value added products can be developed from millets in future to cater to niche segments.

Key words: *Nutricereals, Combination, Dehydrated, Density, Nutritional significance*

Introduction

Millets are of two types, major millets include sorghum, bajra and ragi and minor millets include little, proso, foxtail, kodo and barnyard millets. These millets are rich in all needed nutrients including protein, fat, ash, carbohydrate and crude fibre and minerals like iron, zinc and calcium. This nutritional significance makes them important in making many value added products instead of consuming it as such due to large amount of crude fibre that is present in it and makes them nutrition rich and are palatable for all ages of people. Higher proportion of crude fibre leads to digestion problem and this can be reduced by dehulling and removing the outer coat and then polishing to inactivate the lipase enzyme during storage. Millets are store houses of nutrition and it helps in relieving all stresses, head aches, heart disorders and diabetics. The nutritional benefit of a single millet used in formulating value added product is deficit in certain nutrition and hence this can be corrected using a combination of millets for milk extraction for milk preparation. A known quantity of any one millet and equal amount

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of another millet, was taken for milk extraction. The millets alone are less nutritious than in combinations of millets since malnourishment due to use of single millet can be avoided by combinations of millets based value added products especially in milk beverages (Sheela Puniyamoorthy *et al.,* 2018). The ragi millet is rich in calcium and other millets are low in calcium and this can be reduced with the use of combination of millets. The other combinations of major and minor millets can also be used for combating other nutrients of protein and fat much needed for growing children. The millets selected for making milk beverages include, major millets, sorghum, bajra and ragi and minor millets such as kodo, proso, little, barnyard and foxtail millets. The present study clearly focuses on the utilization of under exploited millets that are good source of energy, proteins and minerals responsible for maintaining healthy blood sugar levels. It is also high in starch content that is a desirable property for extrusion cooking. Composite millets milk powder prepared with the combination of finger millet (*Eleusine coracana*) and pearl millet (*Pennisatum glaucum*) were utilized for preparation of Ready To Cook extruded product. The techniques used for processing the millet milk powder are soaking and extraction of milk from millets, dehydration and milling. The physical and functional properties of the composite millet powder were analyzed.

Materials and Methods

Both major and minor millets were got from gubba storage and then subjected to further processing in grain processing machinery. The millet grains were stored in the refrigerator to avoid any disinfestations. The quality analysis of the millet milk obtained includes carbohydrate, protein, fat, ash and crude fibre using standard procedure and minerals such as iron, zinc and calcium using atomic spectrophotometer. The post harvest technological parameters estimated includes pH of the milk, titratable acidity and total soluble solids were also found out for milk beverages extracted from combination of millets. Different selected combinations of millets include S1, foxtail and little millet, S2, proso and little millet, S3, bajra and proso millet, S4, sorghum and foxtail millet, S5, foxtail & proso millet, S6, sorghum and little millet, S7, sorghum and ragi millet, S8, ragi and little millet, S9, bajra and little millet, S10, bajra and ragi millet, S11, ragi and proso millet, S12,ragi and foxtail millet, S13, sorghum and bajra millet, S14, sorghum and proso millet and S15, bajra and foxtail millet. The carbohydrate was estimated using anthrone method, protein was estimated using micro kjeldahl method, fat was estimated using socsplus, moisture, ash and crude fibre was estimated using AOAC, 2005. The data analysis was done using SPSS 16 version. Graphs were drawn in three dimensional view using design expert software, version, 7.0

Results and Discussion

Milk was extracted by soaking the measured amount of millets, 50g along with the measured amount of water, 100ml for overnight. Then the water was drained and cooked with 200ml water in a pan in a gas stove and then the weight of the cooked millet was determined. The cooked millet was then grinded in a mixie and milk was extracted by filtering through a muslin cloth of 120mesh. The millet milk is extracted by soaking, grinding and filtering the millet milk and the recovery rate is 80%. The raw millets were then soaked for overnight to loosen the inside intact nature of the grain to disrupt the starch from within the grain. The cooked millet milk combina -tion using all selected millet combinations were tested for its quality parameters of pH, total soluble solids, protein, fat, crude fibre and ash were determined. Millet milk extraction in beakers (Fig. 23) and Cooked millet milk beverage (Fig. 24) is shown.

(1)pH was found out using pH unit using 2 electrodes. The range of pH was 4.75-5.76. The millet milk is sour and is acidic in nature. The cooked millet milk was stored in the refrigerator for further quality analysis. pH is minimum in S14 and maximum in S8 treatment. S1, foxtail and little millet, S2,proso and little millet, S3, bajra and proso millet, S4, sorghum and foxtail millet, S5, foxtail & proso millet, S6, sorghum and little millet, S7, sorghum and ragi millet, S8, ragi and little millet, S9, bajra and little millet, S10,bajra and ragi millet, S11, ragi and proso millet, S12, ragi and foxtail millet, S13, sorghum and bajra millet, S14, sorghum and proso millet and S15, bajra and foxtail millet. pH of the millet milk ranges from S9,4.75,-S8, 5.76±0.08,this is in acidic range and it coincides with the earlier findings of plant based milk of coconut, 6.08 and cow's milk, 6.76. pH measures the acidity or alkanity of the product. pH of soy milk ranged between 6.20 to 6.28

(Aloysius Maduforo, 2015). pH of raw millet milk is 3.31±0.04 to 3.85 ± 0.04 and average is 3.63±0.04 (Fig. 1).

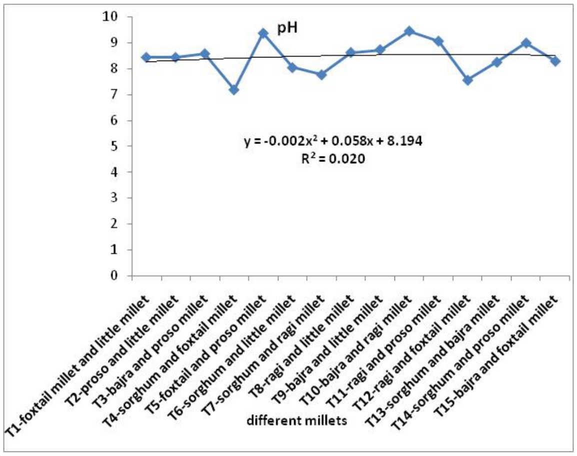

Fig. 1. Millet milk pH for all 15 combinations

(2) Maximum moisture content is found in major millet combination, S1, 98.11%±0.57 and least in minor millet combination, S8, 87.41%±0.54, ragi and little millet. The moisture content is more since water added is more for dilution. (Fig.2)

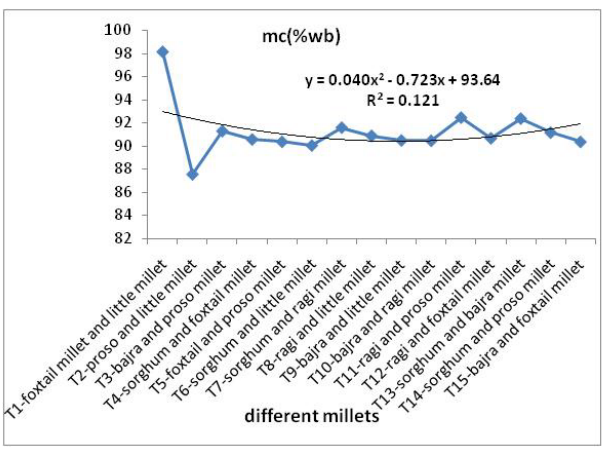

Fig. 2. Millet milk moisture content for all 15 combinations

(3) Total soluble solids was found out using hot air oven method of drying and noting down the weight loss. The total soluble solids was highest in sorghum and little millet, S6, sorghum and little millet, the lowest is found in S13, sorghum and bajra millet. Total soluble solids were estimated using drying by hot air oven method. The range of total soluble solids was 7.18-9.46% and average is 8.44%. Total soluble solids was minimum tss, 0.20%±1.78, S13 and maximum total soluble solids, 6.00%±1.78, S10, total soluble solids is low, since moisture is more in all treatments (Fig. 3). The millet milk total soluble content was found to be 9.17%, the highest coconut milk total soluble solids was 12% as found by Jyotika Dhankar *et al.,* 2019.

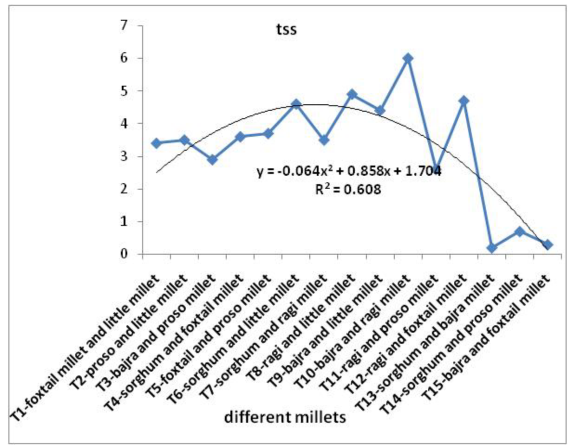

Fig. 3. Millet milk total soluble solids for all 15 combinations

(4)The density of milk and milk products is used to convert volume into mass and vice versa, to estimate the solids content of milk and to calculate other physical properties (e.g. kinematic viscosity). The density of millet milk ranged between S4, 0.72- S10, 0.95g/cc±0.02 and average was found to be 0.84g/cc, minimum total soluble solids is in S4, sorghum and foxtail millet and maximum is in S10, bajra and ragi millet (Fig. 4).

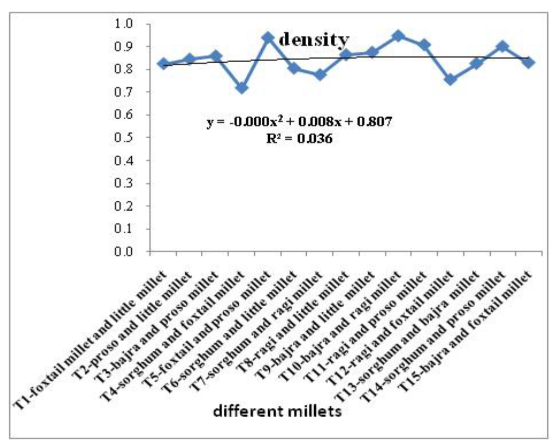

Fig. 4. Millet milk density of tss for all 15 combinations

(5) Carbohydrates, fiber, starches and sugars are essential food nutrients that our body turns into glu-

cose to give energy to function. Minimum carbohydrates is 73.84%±11.37, S4, sorghum and foxtail millet and maximum in S2, 86.93%±11.37, proso and little millet. (AOCC,2000) (Fig.5)

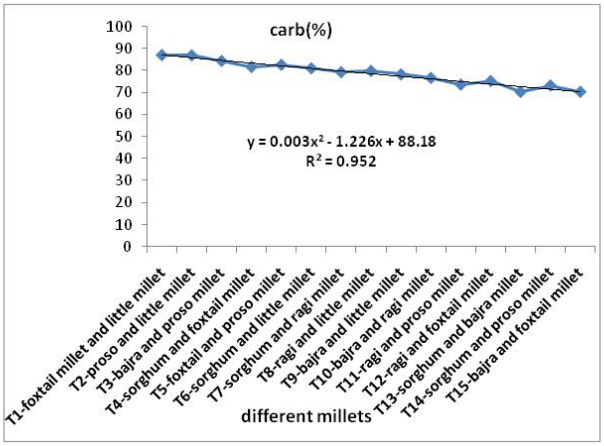

Fig. 5. Millet milk carbohydrates for all 15 combinations

(6) The protein content was found out using Kjeldahl method and fat was estimated using soxhlet apparatus. Each value is the result of the two replications. The average protein content of the treatments ranges from 9.54-14.22%, minimum in the treatment, S8, ragi and little millet and maximum in the treatment, S13, sorghum and bajra millet. The average protein content was 11.36%. Grain protein content is often critical in determining the market value of grain. The protein level is partly determined by the nitrogen nutrition of the plant. The protein content in millet milk beverage sample ranges between 9.54%±0.32, S8 to 14.22%±0.32, S13.The protein content of the millets is on par with that of the millet flour that had a protein content of 13.6% (Fig.6) (Ali *et al.,* 2003).

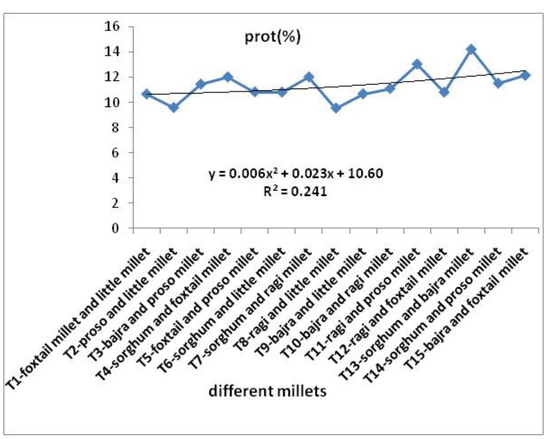

Fig. 6. Millet milk protein for all 15 combinations

(7) The minimum fat content was in S2 and S3, 0.40%±0.08 and maximum in S4,1.40%±0.08. The fat content of the millet milk found in the experiment coincided with the findings by Sunny *et al.,* 2019. The fat content ranged between 0.40%±0.29 to 1.40%±0.29, the average fat content is 0.77%±0.29. (Fig.7) The fat content of the cooked millet milk are found out using soxhlet apparatus, minimum was found to be 0.4%, maximum was 1.4%,average 0.77%. Minimum was in S2, pro -so and little millet and S3, bajra and proso millet and maximum was in S4, sorghum and foxtail millet combination of millet milk beverage. The processing industry determines the fat content in raw materials to assess their suitability for specific processing steps and analyses the fat content of finished products as part of quality control.

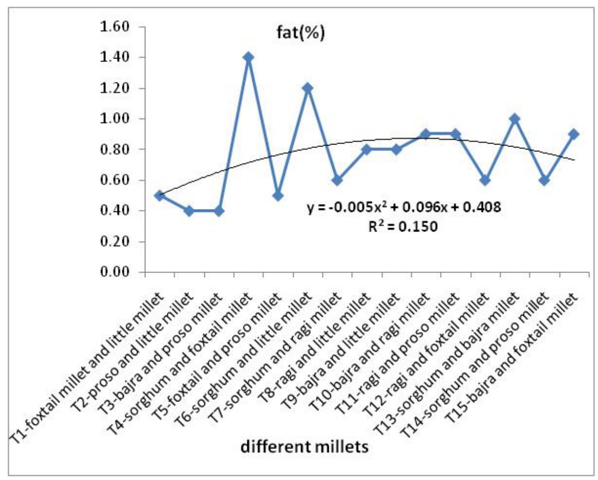

Fig. 7. Millet milk fat for all 15 combinations

(8) Crude fibre is a measure of the quantity of indigestible cellulose, pentosans, lignin, and other components of this type in present foods. The crude fibre content ranged between 3.5%± 1.93, S12 to 99.98%±1.93, S4 & S5. (Fig.8)

(9)Ash content refers to the inorganic matter content present in the sample after complete oxidation of the organic matter present in the sample. The ash content ranged between 0.67 ± 0.08, S14 to 1.87%±0.08, S8 respectively. As the ash content increased, the concentration of millet milk also increased.Ash content represents the mineral content of the millet.(Ragee et. al., 2006) The ash content varied between 0.67%±0.31 to 1.87%±0.31, average ash content is 1.61 % ±0.31%, the crude fibre content varied between 0.04%±0.11 to 1.00%±0.11, average is

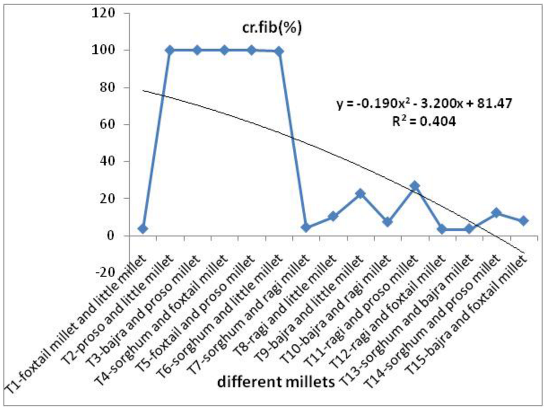

Fig. 8. Millet milk crude fibre for all 15 combinations

0.47 % ± 0.11%, the carbohydrate varied from 83.27%±11.37 to 87.78%±11.37, average is 86.18% ± 11.37, the iron content varied between 35.49±15.40 mg/100g to 86.14±15.40 mg/100g, average is 53.43 ±15.4 mg/100g. The zinc content ranged between 18.78±4.56 mg/100g to 33.99±4.56 mg/ 100g, average is 26±4.56 mg/100g (Fig. 9).

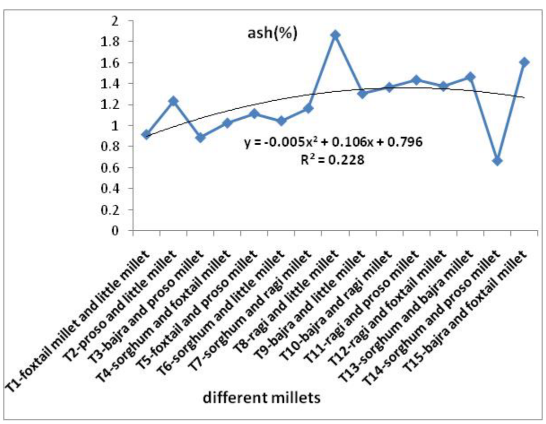

Fig. 9. Millet milk ash for all 15 combinations

(10) Iron is needed for psychomotor development, maintenance of physical activity and work capacity and resistance to infection. (Table 2) Minimum iron was found in S3, 24.87±3.94 mg/ 100g combination of millets and maximum was found in S5,87.28±3.94 mg/100g combination of millets. (AOAC, 1995) (Fig.10)

(11) Zinc are essential micronutrients for human growth, development, and maintenance of the immune system. Maximum zinc was found in S13, 34.14±1.1 mg/100g combination of millets and minimum was found in S5, 18.42±1.1 mg /100g combination of millets. (Fig.11)

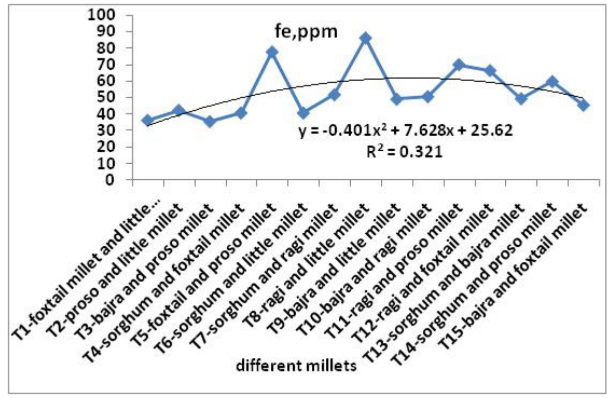

Fig.10. Millet milk iron for all 15 combinations

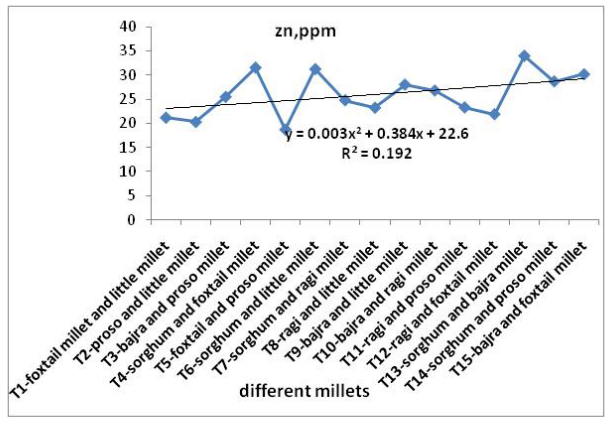

Fig. 11. Millet milk zinc for all 15 combinations

(12)Calcium is an essential nutrient for strong bones and teeth, muscle movement and nerve signals. Minimum calcium was found in S5, 103.6±89.7mg/100g combination of millets and maximum was found in S11, 936.73±89.7mg/100g combination of millets. (Fig.12)

(13) Swelling volume was measured using expansion ratio by cooking method. The cooking ratio was

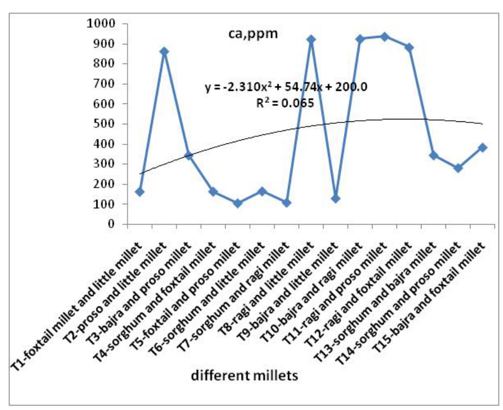

Fig. 12. Millet milk calcium for all 15 combinations

highest in sorghum combination of millets. Expansion ratio of S1 is 2.33, S7 is 2.53, S10 is 2.26 and S13 is 2.24. Expansion ratio is highest in S7, sorghum and proso millet and lowest in foxtail and little millet, S1. Swelling volume was measured using expansion ratio by cooking method. The cooking ratio was highest in sorghum combination of millets. Volume expansion ratio of S1, foxtail and little millet is 2.33, S7, sorghum and ragi millet is 2.53, S10, bajra and ragi millet is 2.26 and S13 is 2.24. Volume expansion ratio is highest in S7, sorghum and proso millet and lowest in S1, foxtail and little millet. (Fig.13)

(14) Microbiological analysis were done to ascertain the shelf life of the stored milk beverage samples. Microbiological plate count for milk beverages samples were done using standard plate count method. Microbiological experiments were conducted for all the samples of combination of selected millets for their plate count by incubating the samples in the incubator at 38°C for 2 days. 1ml of the test solution was taken by a measuring pipette into an autoclaved petridish and then 10ml of dextrose agar solution was added to it and then kept in the incubator at 38°C for 2 days and then the bacterial count was determined by visual observation and counting. The microbial count for all the 15 combinations after storing the millet milk in ambient condition for 4-5 days were tested for samples, the plate count ranged between 8-59%. Plate count for

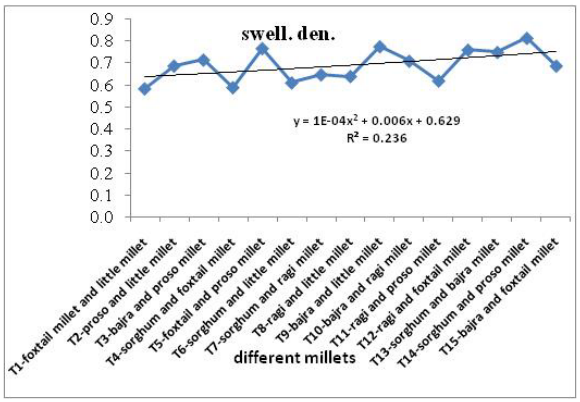

Fig. 13. Millet milk swelling density for all 15 combinations

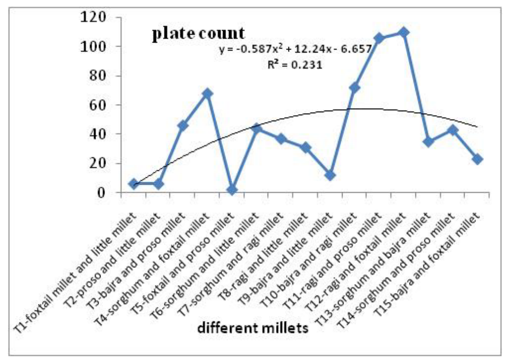

Fig. 14. Millet milk plate count for all 15 combinations

Table 1. Mineral composition of selected millet combinations

sn	Type of millet	Iron, ppm	Zinc, ppm	Ca, ppm	Mc(%wb)	Cv, kcal/g
1	S1-foxtail millet and little	36.21	21.23	161.65	98.11	402.28
2	S2-proso and little millet	42.28	20.35	862.66	87.54	588.84
3	S3-bajra and proso millet	35.49	25.53	342.94	91.27	586.38
4	S4-sorghum and foxtail	40.72	31.55	162.11	90.55	586.84
5	S5-foxtail and proso millet	77.69	18.78	103.60	90.35	577.98
6	S6-sorghum and little millet	40.64	31.26	163.38	90.03	576.50
7	S7-sorghum and ragi millet	51.75	24.83	106.88	91.57	379.26
8	S8-ragi and little millet	86.15	23.29	923.45	90.86	385.38
9	S9-bajra and little millet	49.00	28.05	127.90	90.47	408.08
10	S10-bajra and ragi millet	50.59	26.84	925.00	90.44	373.80
11	S11-ragi and proso millet	69.98	23.36	936.73	92.44	408.48
12	S12-ragi and foxtail millet	66.41	21.96	882.54	90.65	356.48
13	S13-sorghum and bajra	49.36	33.99	343.47	92.35	354.58
14	S14-sorghum and proso	59.75	28.73	280.04	91.14	369.02
15	S15-bajra and foxtail millet	45.39	30.19	382.53	90.34	354.00
	Average	53.43	26.00	446.99	91.21	447.19
	Minimum	35.49	18.78	103.60	87.54	354.00
	Maximum	86.15	33.99	936.73	98.11	588.84
	Sd	15.40	4.56	347.42	2.22	101.15
	Sem	3.98	1.18	89.70	0.57	26.12
	cv	28.83	17.55	77.72	2.43	22.62

samples were 72, 37, 75, 86, 13, 119, 66, 17.5, 32, 47.5, 29, 14.5 and 22.5 for samples from 1 to 15. (Fig.14)

(15) Hedonic scale sensory analysis was carried out for the milk extracted from different combination of millets, the parameters selected were colour, taste, consistency, overall acceptability, appearance, chewiness, texture, flavour and intensity of bitterness for the 15 combinations of millets taken for experimental purposes (Ranganna, 1997) The 6th combination of millet milk got the highest score compared to other combinations. Value added products such as yogurt, lassi, panneer, millet milk powder, biscuits, cakes, muffins, kurkurae, vermicelli and pasta can be made with millet milk to cater to the needs of vegan consumers and lactose intolerant people. The study shows that millet based milk can be used to increase diversity in milk based diets. Moreover, value added products can be developed from millets in future to cater to niche segments.

(16) Calorific value gives the energy content of the selected sample of milk beverage. The calorific value of food is the heat energy produced in the human body during metabolism. Calorific value calculation of food will help in guiding people towards a balanced calorie or food consumption, that would ensure better health. Calorific value of S1 to S15 milk beverage samples were estimated using calculation, Energy(kcal)=4kcal/g protein-1g protein, 9kcal/g fat -1g fat, 4 kcal/g carbohydrate-1g carbohydrate and 2kcal/g crude fibre-1g of crude fibre (Kiranmai, 2018). Two replications were made for all 15 millet milk beverage samples. The calorific value of protein content value ranges between 38.16 kcal to 56.88 kcal. Minimum is in S8, 38.16 kcal±1.26 and ragi and little millet, maximum is in 56.88 kcal±1.26. The calorific value of fat content value ranges between 3.6±0.68 to 12.6 kcal±0.68, minimum is in 3.6 kcal± 0.68 and maximum is in 12.6kcal±0.68. The calorific value of crude fibre content value ranged between 7.00kcal±3.42 to 199.96kcal±3.42, minimum is in S1, foxtail and little millet and maximum is in S11, ragi and proso millet. The calorific value of carbohydrate content ranged between 281.24 kcal±5.56 to 347.72 kcal±5.56, minimum is in S13, 281.24 kcal±5.56, sorghum and bajra millet and maximum is in S1, 347.72 kcal±5.56, foxtail millet and little millet, the total calorific value is minimum in S15,354 kcal±5.46 and maximum is in S2, 409.02kcal±5.45 (Table 2) Average total calorific value is 387.26 kcal±5.46. (Fig.15). Protein, fat, crude fibre, ash, carbohydrate and IVSD and its relation to calorific value in different combinations in graphical figure are shown. (Fig.17, 18, 19, 20, 21 & 22).

(17) The lactic acid in the millet milk beverage for

Table 2. Proximate composition of selected millets

SNo.	Type of millet	Prot (%)	Fat (%)	Cr.fib(%)	Carb(%)	Total cv, kcal/kg
1	S1-foxtail millet and little	42.60	4.50	7.46	347.72	402.28
2	S2-proso and little millet	38.32	3.60	199.80	347.12	588.84
3	S3-bajra and proso millet	45.76	3.60	199.94	337.08	586.38
4	S4-sorghum and foxtail	48.04	12.60	199.96	326.24	586.84
5	S5-foxtail and proso millet	43.32	4.50	199.96	330.2	577.98
6	S6-sorghum and little millet	43.24	10.80	198.70	323.76	576.50
7	S7-sorghum and ragi millet	48.04	5.40	8.94	316.88	379.26
8	S8-ragi and little millet	38.16	7.20	20.86	319.16	385.38
9	S9-bajra and little millet	42.68	7.20	45.32	312.88	408.08
10	S10-bajra and ragi millet	44.36	8.10	14.78	306.56	373.80
11	S11-ragi and proso millet	52.16	8.10	53.74	294.48	408.48
12	S12-ragi and foxtail millet	43.20	5.40	7.00	300.88	356.48
13	S13-sorghum and bajra	56.88	9.00	7.46	281.24	354.58
14	S14-sorghum and proso	46.04	5.40	24.70	292.88	369.02
15	S15-bajra and foxtail millet	48.56	8.10	15.94	281.40	354.00
16	average	45.42	6.90	80.30	314.57	447.19
17	minimum	38.16	3.60	7.00	281.24	354.00
18	maximum	56.88	12.60	199.96	347.72	588.84
19	sd	4.89	2.63	88.36	21.54	101.15
20	sem	1.26	0.68	22.82	5.56	26.12
21	cv	10.76	38.08	110.04	6.85	22.62

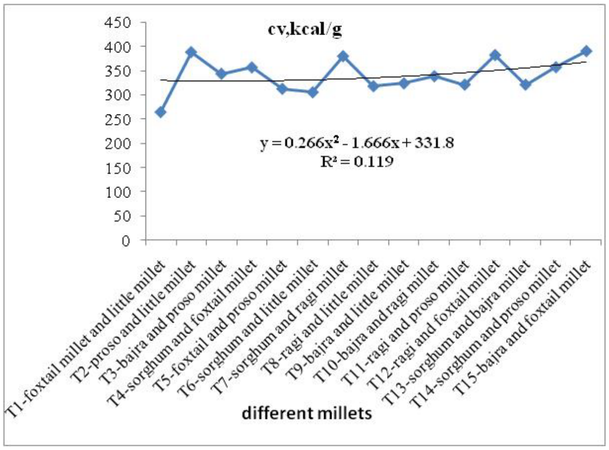

Fig. 15. Millet milk total calorific value for all 15 combinations

S1 to S15 were determined and found to be highest in S6, 0.63 and lowest in S1 and S2, 0.10. The normal acidity of individual cow milk ranges from 0.10 to 0.26% lactic acid. This coincided with the earlier findings of Sudha *et al.*, 2016, Jyotika Dhankar *et al.*, 2019 and in almond milk the % titratable acidity is much less, 0.39% (Bernat *et al.*, 2015).

(18)Invitro starch digestability is a measure of carbohydrate digestability. The invitro starch digestibility is measured in maltose released per 100g of sample (Singh *et al.*, 1982). More the IVSD value, easy digestion and absorption of starch is the indication. IVSD is measured by spectrophotometer based on reflectance principle at 550nm. The invitro starch digestibility of the treatment samples were found out using standard biochemical procedure given by Singh *et al.*, and it ranged between 0.64%±5.93 to 52.64%±5.93 for millet milk beverage samples. Average value is 14.81%±5.93, minimum value is 0.64%±5.93, maximum is 58.80%±5.93. Cv is 14.98. Invitro starch digestibility (IVSD) is minimum in S1, 0.64%±5.93 and S3,0.64%±5.93 followed by S10, 1.28%±5.93, S9, 1.44%±5.93, T2, 1.52%±5.93, S11, 1.60%±5.93, S4, 1.68%±5.93, T12, 2.60% ±5.93, S6 3.13% ± 5.93, S14, 8.48%±5.93, S7, 20.96%±5.93, S15,

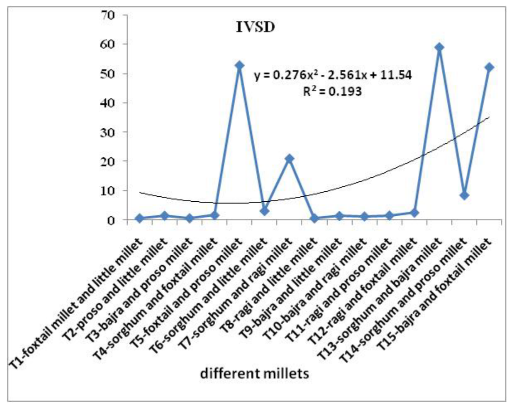

Fig. 16. Millet milk IVSD for all 15 combinations

Table 3. Proximate composition of selected millets

SN	Type of millet	Pr (%)	Fat (%)	Cf (%)	Ash (%)	Car (%)	IVSD(%)
1	S1-foxtail millet and little	10.65	0.50	3.50	0.92	86.93	0.64
2	S2-proso and little millet	9.58	0.40	9.99	1.24	86.78	1.52
3	S3-bajra and proso millet	11.44	0.40	9.97	0.89	84.27	0.64
4	S4-sorghum and foxtail	12.01	1.40	9.99	1.03	81.56	1.68
5	S5-foxtail and proso millet	10.83	0.50	9.99	1.12	82.55	52.64
6	S6-sorghum and little	10.81	1.20	9.93	1.05	80.94	3.12
7	S7-sorghum and ragi	12.01	0.60	4.47	1.17	79.22	20.96
8	S8-ragi and little millet	9.54	0.80	10.43	1.87	79.79	0.64
9	S9-bajra and little millet	10.67	0.80	22.66	1.31	78.22	1.44
10	S10-bajra and ragi millet	11.09	0.90	7.39	1.37	76.64	1.28
11	S11-ragi and proso millet	13.04	0.90	26.87	1.44	73.62	1.60
12	S12-ragi and foxtail millet	10.80	0.60	3.50	1.38	75.22	2.56
13	S13-sorghum and bajra	14.22	1.00	3.73	1.47	70.31	58.8
14	S14-sorghum and proso	11.51	0.60	12.35	0.67	73.22	8.48
15	S15-bajra and foxtail millet	12.14	0.90	7.97	1.61	70.35	52.00
	Average	11.36	0.77	40.14	1.24	78.64	14.81
	Minimum	9.54	0.40	3.50	0.67	70.31	0.64
	Maximum	14.22	1.40	99.98	1.87	86.93	58.80
	Sd	1.22	0.29	44.64	0.31	44.04	5.93
	Sem	0.32	0.08	11.93	0.08	11.37	22.19
	cv	10.76	38.08	11.22	24.82	56.00	14.83

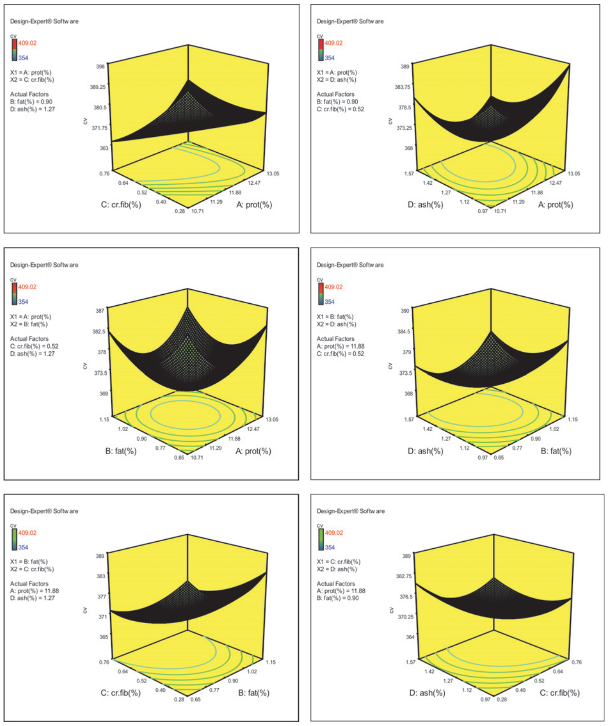

Fig. 17. 3d graphs showing the calorific value and its relation to different nutrients in millet milk in different combinations

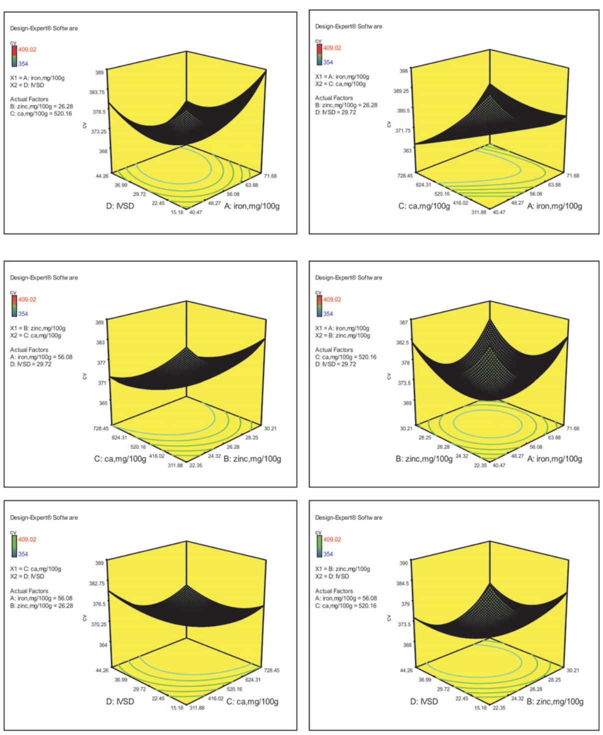

Fig. 18. 3d graphs showing the calorific value and its relation to different nutrients in millet milk in different combinations

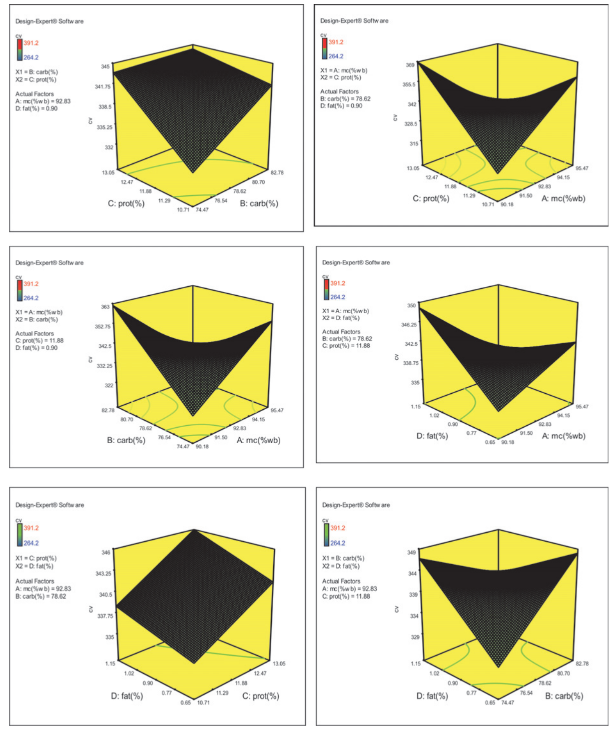

Fig. 19. 3d graphs showing the calorific value and its relation to different nutrients in millet milk in different combinations

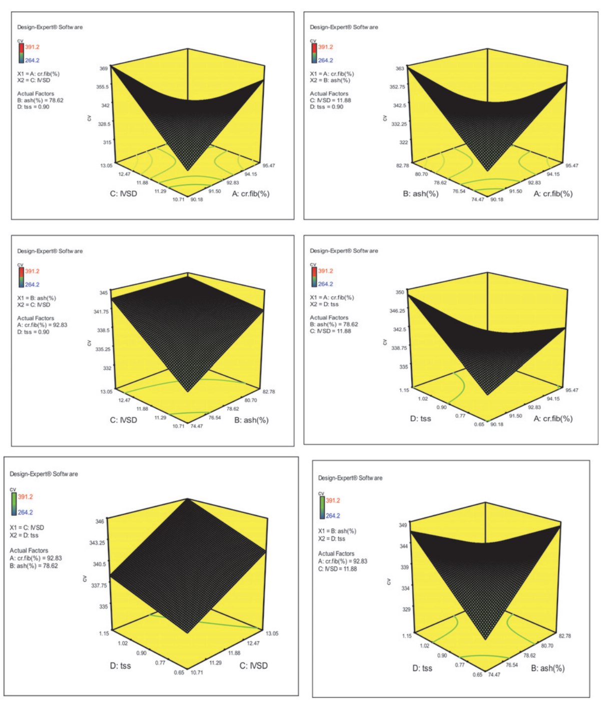

Fig. 20. 3d graphs showing the calorific value and its relation to different nutrients in millet milk in different combinations

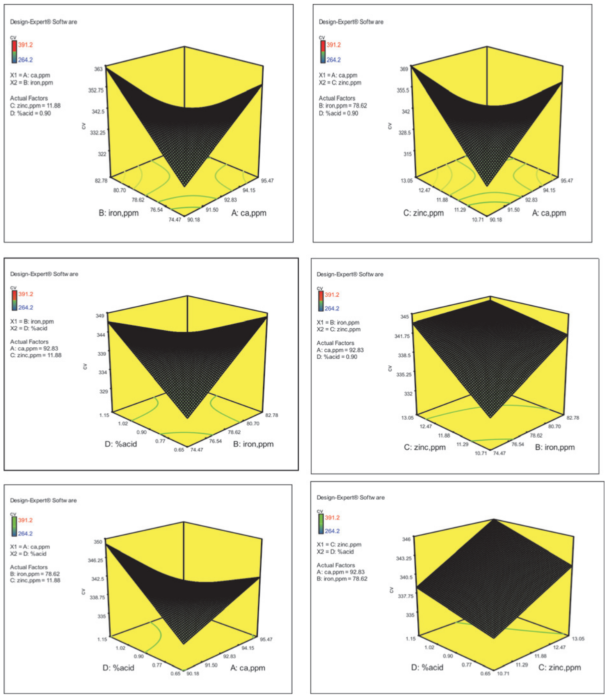

Fig. 21. 3d graphs showing the calorific value and its relation to different nutrients in millet milk in different combinations

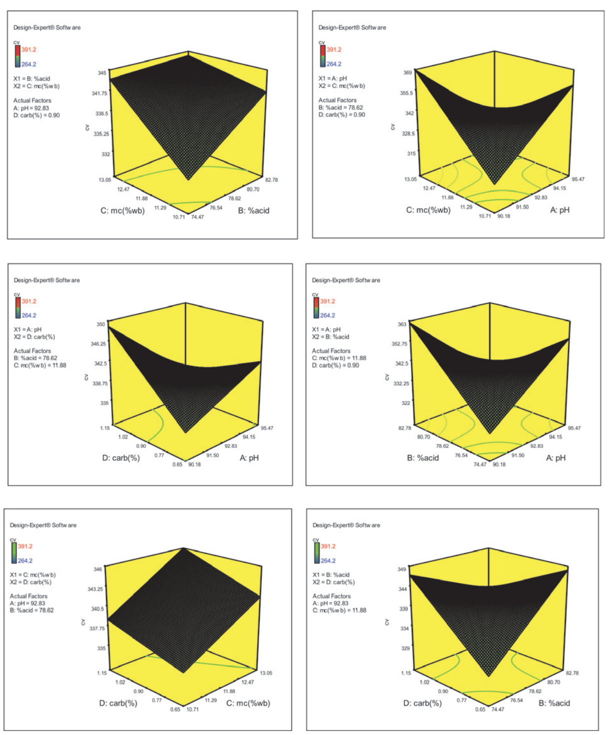

Fig. 22. 3d graphs showing the calorific value and its relation to different nutrients in millet milk in different combinations

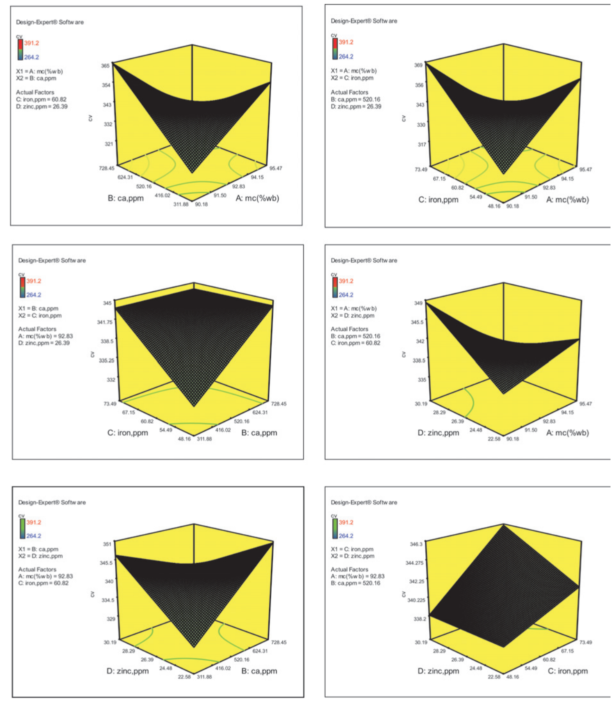

Fig. 23. 3d graphs showing the calorific value and its relation to different nutrients in millet milk in different combinations

Fig. 24. Millet milk extraction in beakers

Fig. 25. Cooked millet milk beverage

52%±5.93, S5, 52.64% ±5.93 and S13, 58.8%±5.93. The value are significant at 5% level of significance done with SPSS software 16.0 version. The values are obtained with 2 replications. The invitro starch digestability is used to ascertain the starch content of the millet milk beverage samples. The lower the invitro starch digestibility, less is the amylase content of the starch and this is due to the retrogradation of cooking of the starch and the formation of resistant starches to digestion. (Shunmugapriya *et al.,* 2020). The values were significant at 5% level of significance. ($p \leq 0.05$). Statistical analysis was done using SPSS software 16.0 version (Fig.16). Fig. 17-23 are 3d graphs showing the calorific value and its relation to different nutrients in millet milk in different combinations.

Conclusion

All plant based milks are preferred over cow's milk by consumers and are lactose intolerant or are allergic to milk proteins because of their common benefits of being lactose free, cholesterol free and low in calories. Flavouring agents to improve the taste or flavor and nutrients in the form of additives may be added to obtain the desired nutritive balance. The stability of plant based beverages can also be improved by using emulsifiers and stabilizers. In plant based milks three factors namely, size of the particle, formation of an emulsion and solubility of proteins governs the stability. Millet being a poor man's crop has diversified uses and if tapped properly can be used for many value added products in a cost economic way. Poor people cannot afford for natural cow's milk and is unavailable in certain households and this lacuna can be eradicated using the millet milk. The millet milk like that of other grain milk extractions are rich in all needed ingredients of body building including carbohydrate, protein, calcium, fat and other minerals. Milk is a very important commodity in daily diet and it offers several benefits including strengthening of bones, bone formation in infants, growth of the children, whiteness to teeth and teeth formation. This milk is usually got from animals such as cows and goats. Millet millet is very nutritious and owing to its calcium content that gives strength and ability to develop bones and teeth it is being recommended in formulation of infant foods and incorporation in making value added product that gives more white in color and fetches more price in the market.

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