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Development and Evaluation of Pre-gelatinized Malted Millet Mix by using Pearl and Foxtail millet

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ABSTRACT: Malting is an low cost and potent method for improving the nutritional quality of food grains by enhancing their digestion and decreasing the contents of anti nutritional factors. Malting result by biochemical modification includes increase in free amino acids and total sugars and decrease in starch content, and increased protein quality. Malted mix was prepared from germinated malted foxtail and pearl millet flour with addition of skim milk powder and cocoa powder. Alpha amylase activity of pearl and foxtail millets were 144±0.51 and 179.67±0.33 µ moles of maltose respectively. Vitamin C content of the foxtail and pearl millets were 9.17±0.05 and 9.02±0.04 mg/100g respectively. Sensory analysis involving 15 semi trained panel members concluded that the combination (T_4) of foxtail millet flour (20 g), pearl millet flour (55 g), skim milk powder (5g) cocoa powder (10g) and sugar powder(10g) have more acceptance compared to other proportion of the combinations. The results of sensory scores for the T_4were appearance (8.26±0.88), colour (8.06±0.30), flavour (7.67±0.33), taste (7.80±0.26) and overall acceptability (7.87±0.30). The combinations of germinated and malted foxtail and pearl millet flour enhanced the nutritive value of the product with vitamin C content, dietary fibre, amino acids, anti-oxidants and minerals.

Keywords: Malting, Amylase activity, Foxtail millet, Pearl millet, Sensory analysis.

INTRODUCTION

Millets are cereal grains that are grown all over the world and are members of the Poaceae (Gramineae) family (Zhu, 2014). They possess high nutritional value and are staple meal for many people in developing countries (Mridula and Sharma 2015). Millets are nutritionally comparable to major cereals and serve as a good source of protein, micronutrients and phytochemicals (Saleh *et al*., 2013). Millets contain 7-12% protein, 2-5% fat, 65-75% carbohydrates and 15-20% dietary fibre. Among them, pearl millet contains a considerably high proportion of proteins (12-16%) as well as lipids (4-6%) (Taylor and Duodu 2015). Millets as a whole show prebiotic activity, which help to increase the population of probiotic bacteria that play a key role in promoting digestion. Fermented millet products act as a natural probiotic treatment for diarrhea in young children (Bhat *et al*., 2017).

Millets are the major food of developing countries. In developing countries the area of production and cultivation of millets is three fourth. From the year 1961 to 2018 according to the estimates the millet cultivation was decreased to 25.71%. In India, millet production highest in the 1980s and then decreased as a result of an increasing reduction in the area that is cultivated. India produces the most millets, accounting for 37.5% of the total global output, followed by Sudan and Nigeria. For the year between 2011 and 2017 had maximum import and export values of millets in terms of trade. (Meena *et al.*, 2022).

The important nutrients present in millets include resistant starch, oligosaccharides, lipids, antioxidants such as phenolic acids, avenanthramides, flavonoids, lignans and phytosterols which are believed to be responsible for many health benefits (Yousaf *et al.*, 2021). Millets have potential health benefits and epidemiological studies have shown that consumption

of millets reduces the risk of heart disease, protects from diabetes, improves the digestive system, lowers the risk of cancer, detoxifies the body, promotes respiratory health, increases energy levels and improves muscular and neural systems and are protective against several degenerative diseases such as metabolic syndrome and Parkinson's disease (Chandrasekhara and Sahidi 2012).

Malting is a metabolic process that helps in the formation of a wide range of hydrolytic enzymes and bioactive substances by the germination of grains (Banusha and Vasantharuba 2013). When grains are malted, endogenous enzymes begin to transform the grain's contents, which include soluble sugars, protein, and enzymes (Nadeem *et al.*, 2010). Thus, malting enhances the nutritive content, improves the digestibility and increases the bioavailability of nutrients. Keeping in view of all the above points, this study was taken up to develop and evaluate the malted millet mix using pearl and foxtail millets.

Millets are potent source of phytochemicals like phenolics, sterols, lignans, inulin, resistant starch, β-glucan, phytates, tocopherol, dietary fiber and carotenoids. The polyphenols are the phenolic acids and tannins, flavonoids are present in small quantities; which act as antioxidant and play a role in the body immune system (Sucharitha and Anbati Kiran 2019). Malting greatly increases the nutritional bioavailability of several micronutrients that includes fibre, fat, vitamins B and C.

Millets contribute for sustainable to beat the hunger in worldwide by in built drought resistance, changes in the climatic conditions. It is resistant to climstic stress, pests and diseases. Nutritional security with good quanitity of micronutrients like calcium, zinc, iron and iodine. With gluten free nature health security is also possible with millet (Kumar *et al.*, 2018). Low glycemic index compared to other cereal grains helps in controlling diabetes.

Germination is an oldest and cheapest method of improving overall nutritional quality of millet grains. Germination increased the micro nutrients present in the millet grains like calcium, iron. Phosphorous levels (Sangma *et al.*, 2019). From epidemiological evidences it is clear that they protect from diseases like cancer, diabetes and cardiovassucular diseases (Saleh *et al.*, 2013).

Raw material. Finger Millet (*Eleusine coracana*), Pearl Millet (*Pennisetum glaucum*), Foxtail Millet (*Setariaitalica*), Kodo Millet (*Paspalum scrobiculatum*), Sorghum (*Sorghum bicolor*), Barnyard Millet (*Echinochloa esculenta*), Little Millet (*Panicum sumatrense*) and Browntop Millet (*Brachiaria ramose*) were sourced from the local farmers of Nandyal, Andhra Pradesh.

Estimation of Vitamin C. The Vitamin C in the germinated millets was determined as per the methodology adopted by Omaye *et al*. (1979). Ascorbic acid reduced 2,6-dichlorophenol indophenol dye to a colourless leuco base and got oxidized to dehydroascorbic acid, changing the dye color to pink.

Estimation of α-amylase activity. The α-amylase activity in the germinated millet was assayed as per the method described by Malleshi and Desikachar (1986). An aliquot of 0.5 ml enzyme solution was added with 0.5 ml of starch solution and incubated at 30°C for 30 minutes. The reaction was stopped by adding 1.0 ml Bernfeld's colour reagent. The colour would change to pink during heating in a boiling water bath for 5 minutes. After cooling, 10 ml of water was added and the absorbance read at 540 nm.

Processing of Pearl and Foxtail Millet flours. Among the eight millets originally considered, only two millets viz. pearl and foxtail millets were selected based on Vitamin C content and α-amylase activity. These two millets were washed and soaked for 12 hours in fresh water. After draining excess water, they were covered in a muslin cloth and tied, kept at room temperature for 48 hours for germination. After germination, they were dried in a solar dryer for 48 hours. Dehusking of millets was done followed by pre-gelatinization at 85ºC for 15 minutes. The pre-gelatinized millets were dried in a tray drier at 65ºC for 16 hours. Dried millets were pulverized to make them into fine powders (Ren *et al.*, 2016).

Development of Malted Millet Mix. Pearl and foxtail millets were used for formulating malted millet mix. Six formulations of malted millet mixes were developed, 100g each, by incorporating Foxtail and Pearl millet flour. The following are the formulations developed.

Table 1: Formulations developed for standardizing malted millet mix.

Formulation	FMF (g)	PMF (g)	SMP (g)	SP (g)	CP (g)
T_1	5	70	5	10	10
T_2	10	65	5	10	10
T_3	15	60	5	10	10
T_4	20	55	5	10	10
T_5	25	50	5	10	10
T_6	30	45	5	10	10

FMF: Fox Tail Millet Flour, PMF – Pearl Millet Flour, SMP – Skim Milk Powder, SP: Sugar Powder and CP: Cocoa Powder

Sensory Evaluation. Six formulations of the malted millet mixes were subjected to sensory evaluation by panel consisting of 15 semi trained members using 9 points Hedonic scale. Sensory attributes *viz.* colour, appearance, taste, flavour and overall acceptability were evaluated.

RESULTS AND DISCUSSION

Vitamin C. Vitamin C analysis revealed that the germination process enhanced vitamin C constant significantly in all the millets (Table 2). The percentage of increase in vitamin C content ranged from 8.12% to 77.71%. The highest increase was recorded by foxtail

millet followed by pearl millet (63.70%) and the lowest vitamin C content was observed in little millet. The increase in vitamin C during malting/germination is driven by the enzymatic hydrolysis of starch by amylases and diastases that increased the availability of glucose for the biosynthesis of vitamin C. It is this enhanced content of glucose that acted as a precursor for the formation of vitamin C (Desai *et al*., 2010). Panda *et al.* (2020) reported that germinated pearl millet recorded higher Vitamin C content when compared with other germinated millets. Germination effected moisture content has significantly decreased in little millet and no difference was observed in barnyard and foxtail millet. Similar results were reported in pearl millet, finger millet, sorghum (Singh *et al*., 2017), maize (Anaemene and Fadupin 2020).

Table 2: Comparison of Vitamin C content in raw and germinated millets (Mean±SE)[@].

Name of the Millet	Vitamin C content (g/100mg)		% Increase
	Raw Millet	Germinated Millet	
Finger Millet	2.13±0.01^{d}	3.31±0.12^{b}	55.39%
Little Millet	1.6±0.02^{e}	1.73±.0.03^{e}	8.12%
Kodo Millet	1.33±0.15^{f}	1.87±0.22^{d}	40.60%
Barnyard Millet	1.15±0.08^{f}	1.85±0.09^{d}	60.87%
Foxtail Millet	5.16±0.08^{b}	9.17±0.05^{a}	77.71%
Sorghum Millet	2.36±0.10^{d}	2.97±0.03^{c}	25.85%
Pearl Millet	5.51±0.09^{a}	9.02±0.04^{a}	63.70%
Brown top Millet	2.65±0.04^{c}	3.05±0.03^{bc}	15.09%
F- Value	**374.37****	**935.26****	

@ Average of 6 trials.
** Highly significant
Means bearing different superscripts across column differ significantly

Alpha amylase activity. The results of α-amylase activity (expressed in mg of maltose) showed a significant increase in all the millets after germination as depicted in Table 3. Pearl millet recorded the highest activity (179.67±0.33) followed by foxtail millet (155±0.51) and the least was seen in brown top millet (7.16±0.60). An increase in free sugars during germination leads to an increase in α-amylase activity in germinated millets. Similar results were reported by Singh *et al*. (1988) in germinated finger millet.

Table 3: Comparison of α-amylase activityin raw and germinated millets (Mean±SE)[@].

Name of the Millet	α-amylase activity(mg of maltose)	
	Raw Millet	Germinated Millet
Finger Millet	1.21±0.07^{c}	155±0.51^{b}
Little Millet	0.4±0.02^{e}	11.5±0.22^{f}
Kodo Millet	0.71±0.03^{d}	10.8±0.30^{f}
Barnyard Millet	0.73±0.03^{d}	42.83±0.94^{e}
Foxtail Millet	3.45±0.09^{b}	144±0.51^{c}
Sorghum Millet	0.53±0.03^{e}	61.83±0.74^{d}
Pearl Millet	4.25±0.07^{a}	179.67±0.33^{a}
Brown top Millet	0.21±0.01^{f}	7.16±0.60^{g}
F- Value	**802.53****	**15814.36****

@ Average of 6 trials.
** Highly significant
Means bearing different superscripts across column differ significantly

Sensory Evaluation. As the level of pre-gelatinized germinated foxtail millet flour increased in the formulation, there was a significant decrease in the overall acceptability, especially in terms of flavour and taste attributes. A peculiar taste and light-yellow colour of foxtail millet was the reason for the lower acceptability in the formulations with high foxtail millet flour addition (Ekta Belwal and Sujatha 2021). T_4 formulation recorded the highest scores in all the sensory attributes like appearance (8.26±0.88), colour (8.06±0.30), flavour (7.67±0.33), taste (7.80±0.26) and overall acceptability (7.87±0.30). This formulation contained 20g of Foxtail Millet Flour and 55g of Pearl Millet flour.

Table 4: Sensory Evaluation of Malted millet Mix (Mean±SE)[@].

Treatment	Sensory characteristics				
	Appearance	Colour	Flavour	Taste	Overall acceptability
T_1	7.20±0.24^{b}	7.46±0.74	6.73±0.24^{b}	6.73±0.37^{bc}	6.53±0.25^{b}
T_2	7.46±0.25^{ab}	7.53±0.21	7.00±0.21^{ab}	7.20±0.24^{ab}	7.40±0.21^{ab}
T_3	7.33±0.41^{ab}	7.33±0.36	7.33±0.30^{ab}	7.07±0.31^{ab}	7.27±0.35^{ab}
T_4	8.26±0.88^{a}	8.06±0.30	7.67±0.33^{a}	7.80±0.26^{a}	7.87±0.30^{a}
T_5	7.06±0.47^{b}	7.73±0.36	6.73±0.30^{b}	6.13±0.27^{c}	7.07±0.38^{ab}
T_6	7.40±0.27^{ab}	7.80±0.22	6.46±0.29^{b}	6.73±0.26^{bc}	6.93±0.28^{ab}
F- Value	1.67NS	0.92NS	2.32*	3.66**	2.17NS

@average scores of 15 semitrained members
**highly significant, * Significant and NS – Non Significant
Means bearing different superscripts across column differ significantly

Statistical Analysis. Data were subjected to a one-way compared by Duncan's multiple comparison tests at a P≤0.01 (Snedecor and Cochran 1994).

CONCLUSIONS

Millet based malted pre-gelatinized mixes are nutritionally rich in dietary fibre compared to malted products available in the market. Eight millets were subjected to germination and Vitamin C and alpha amylase activity were analysed. Based on Vitamin C and alpha amylase activity, two millets, *viz.*, pearl and foxtail millets were selected. Germination significantly increased after germination in millets and the percentage increase in Vitamin C after germination was highest in foxtail millet followed by pearl millet. Alpha amylase activity was found to be higher among pearl and foxtail millets. Among all the treatments, T_4consisting of 20 parts of pre-gelatinized foxtail millet flour, 55 parts of pre-gelatinized pearl millet flour, 5 parts of cocoa powder, 10 parts of skim milk powder and 10 parts of sugar powder was highly accepted by the panel of semi trained persons.

FUTURE SCOPE

Malting of millets has opened new opportunities for consumers who always demand food products rich in nutrients, energy and dietary fibre. Malt based products that exist already in the market are mostly without millets. Pre-gelatinized pearl and foxtail malted millets can be used as base for formulating energy rich, fibre rich, weaning and other functional foods.

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