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Improving Nutritional Value of Butter Milk by Blending with Dry Leaves of *Moringa oleifera*

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Abstract: The main objective of this study was to improve the nutritional value of butter milk by blending with dry leaves of *Moringa oleifera* that can be used to prevent and correct malnutrition in women and children of this poor nation. Dry leaves of *Moringa oleifera* was incorporated into butter milk at three different concentrations i.e. 1% addition (T_1), 2% addition (T_2) and 3% addition (T_3). All these treatments were compared with a control T_0 without any addition of dry leaves of *Moringa oleifera* (100% butter milk). Addition of dry leaves of *Moringa oleifera* at all levels did not have any negative effect on pH and acidity of the fortified butter milk. Protein and ash content increased from 3.41-4.09% and 0.75-1.13% which was 20 and 50% respectively at T_3 level. Iron and calcium content of the fortified butter milk increased from 0.03-6.77 and 117.22-174.34 mg/100 grams in T_3. Vitamin C, B_1, B_2 and B_3 increased by 168, 233, 393 and 624% respectively as compared to control. Addition of dry leaves of *Moringa oleifera* at T_2 level did not have any significant effect on color, taste and overall acceptability scores. The overall acceptability score of T_3 was 6.7 out of 9 which was more than 74%. It was concluded that dry leaves of *Moringa oleifera* can be used at T_3 level (3% addition) to formulate fortified butter milk with increased health benefits and acceptable sensory attributes.

Key words: Butter milk, malnutrition, *Moringa oleifera*

INTRODUCTION

Pakistan is a homeland of 180 million people, many school going babies, pregnant and lactating women suffer from protein, iron, vitamins and minerals deficiencies. According to a survey, 60% of the nursing women and 40% of the school going children below the age of 10 years suffers from anemia (Nishtar, 2002) which results in poor growth and lack of resistance against diseases. Many rehabilitation programmes were started by WHO, USAID, UNICEF and local non government organizations but significant success could not be attained due to non sustainability of such plans. This poor nation can not afford costly supplements as 50% of the population is living on less than one US $ dollar per day (Government of Pakistan, 2006). There is a dire need to find out the economical and sustainable ways of fortification. Butter milk is a bye product obtained from churning sweet or sour cream (Walstra *et al*., 2006). Most of the butter milk is manufactured in this country by conventional method at home level and butter milk produced at industrial level is discarded due to lack of knowledge of value addition of this highly valuable bye product and for having no market value. The livestock sector of Pakistan is spread over thousands of square kilometers with average two to three animals per farm. 70% of the people who are living in the villages make their own butter and ghee, the butter milk produced in this way is consumed as such (Otto *et al*., 2002). Butter milk can be used as a media for the carrying of fortification material. Therapeutic value of butter milk is high and is a good source of many vitamins and minerals (Speer, 2005). *Moringa oleifera* is a popular tree in Pakistan and it is often used as backyard tree for the purpose of shade and most of the people are not familiar with the massive nutritional potential of this miraculous tree. Dry leaves contain 17 times more calcium than milk, 28 mg iron is present in dried leaves as compared to 1.14 mg in spinach (per 100 grams) and protein content is 27.2 gram as compared to yoghurt 3.1 gram per hundred grams. It contains arginine and histidine which are especially important for infants; it contains all essential amino acids and may be rightly called a complete food for total nutrition Ferrao and Ferrao (2005). For the reason present study was planned to fortify the butter milk with different concentration of dry leaves of *Moringa oliefera* and find out the suitability of dry leaves of *Moringa oliefera* fortification in butte milk on the basis of certain physico-chemical and sensory characteristics.

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MATERIALS AND METHODS

Collection of raw materials: *Moringa oleifera* leaves were obtained from Ayub Agricultural Research Institute Jhang Road, Faisalabad. Leaves were washed with plenty of water to remove, dirt and dust, dried in the sun and stored in air tight plastic container till further usage.

All the chemicals used in this study were obtained from reputable scientific suppliers of Lahore and were reagent grade.

Experiment: The experiment was involved in making three different types of fortified butter milk. Dry leaves of *Moringa oliefera* were incorporated into butter milk at three different concentrations i.e. 1% addition T_1, 2% addition T_2 and 3% addition T_3. All these treatments were compared with a control T_0 without any addition of MOLP (100% butter milk). After addition of dry leaves of *Moringa oliefera* the mixtures were blended in electronic blender and filled in clean and sanitized pet bottles at 4°C for subsequent analysis.

Analysis: Butter milk samples were analyzed for pH, acidity, fat, protein, lactose, ash content and total solids by following the respective methods of AOCS (1990). Sodium, potassium, magnesium and calcium were determined on atomic absorption spectrophotometer as per methods of AOAC (2000). Concentration of iron in whey drink samples was determined by using the method of AOAC (2000). Vitamin assay was carried out on HPLC by following the respective methods as given in AOAC (2000).

Sensory evaluation: The sensory evaluation of fortified butter milk was carried out by 75 ladies of different villages. The sensory evaluation was done on a 9 point hedonic scale (1-the worst; 9-the best) as prescribed by Larmond (1987). The samples were evaluated for texture, taste, smell and overall acceptability. Samples were presented in glass dishes and coded with three digit random numbers and all orders of servings were completely randomized.

Statistical analysis: The data was obtained by applying Completely Randomized Design (CRD) and the outcome of the data was analyzed through analysis of variance technique as described by Steel *et al.* (1997). The separation of means or significant difference comparisons was made by using Duncan's Multiple Range Test (DMR).

RESULTS AND DISCUSSION

The results of chemical composition of different treatments of fortified butter milk are presented in the Table 1 which indicated that addition of dry leaves of *Moringa oliefera* at all levels did not have any adverse effect on pH and acidity of fortified butter milk. pH and acidity ranged from 5.2-5.3 and 0.49-0.58% among different treatments and control. pH and acidity of all the experimental samples were at par with each other and control ($p>0.05$). This non significant effect on pH and acidity of all the samples was due to the neutral nature of *Moringa oleifera* leaves. pH and acidity of butter milk should be in the range of 0.4-0.7% Speer (2005). Augmentation of *Moringa oleifera* leaves at all levels did not have any significant effect on fat content of fortified butter milk. Fat content slightly increased with increasing augmentation of *Moringa oleifera* leaves. The non significant effect could be attributed to the low fat content in dry leaves and secondly the lower augmentation levels (1-3%). The lower fat content in butter milk is a desirable attribute and higher fats in the butter milk may not be desirable for many health conscious people as butter milk is mostly consumed for its health promoting characteristics. Protein content momentously increased with increasing levels of dry leaves of *Moringa oleifera* in the butter milk and increased from 3.41% (control) to 4.09% (T_3). Protein content was increased by approximately 20% at 3% augmentation level. The increase in protein content was due to the presence of higher concentration of protein in *Moringa oleifera* leaves. The quality of protein in dry leaves of *Moringa oleifera* is better than all vegetable proteins and similar to egg and milk proteins as it contains all the essential amino acids in appreciable amounts manner Juliani *et al.* (2008). Fuglie (1999) studied the effect of *Moringa oleifera* fortification on heath of school going babies and pregnant women in Senegal and reported that fortification with *Moringa oleifera* significantly improved the health of young children and pregnant women who consumed *Moringa oleifera* fortified diet gave birth to healthy babies. It was recommended that fortification of food from various parts of this miraculous tree should be carried out to rectify the malnutrition problems of the poor nations. In an other study while studying the effect of feeding *Moringa oleifera* leaves and pods to pregnant women Price (1985) reported that feeding 100 grams *Moringa oleifera* on daily basis to nursing and pregnant women can provide significant amount of calcium, copper, iron, sulfur and B-vitamins and can save theme from threats of malnutrtion. Ash content and total solids increased by 50 and 27% at T_3 level. Quarcoo (2008) developed beverage from the leaves extract of *Moringa oleifera* and reported that protein content of the beverage was 2.9% as compared to 0.54 and 1% in pineapple and carrot beverage. It was observed that protein content of the leaves extract of *Moringa oleifera* were 4.8%. Fat content of the beverage was 1.8%. The reason for low fat content in our study was due to the low level of fortification of *Moringa oleifera*, also the fat content of the butter milk was on the lower side which presented very low fat in the fortified butter milk samples at all levels.

Table 1: Effect of fortification on chemical composition of fortified butter milk

Treatments	pH	Acidity (%)	Fat (%)	Protein (%)	Lactose (%)	Ash (%)	TS (%)
T_0	5.20±0.11a	0.53±0.03a	0.92±0.13a	3.41±0.19d	4.23±0.23a	0.75±0.15d	9.94±0.31d
T_1	5.24±0.07a	0.50±0.11a	0.93±0.14a	3.60±0.23c	4.15±0.19a	0.84±0.19c	10.77±0.35c
T_2	5.22±0.19a	0.58±0.01a	0.94±0.09a	3.89±0.31b	4.14±0.14a	0.97±0.10b	11.88±0.43b
T_3	5.30±0.13a	0.49±0.04a	0.97±0.17a	4.09±0.37a	4.10±0.10a	1.13±0.17a	12.65±0.56a

TS: Total Solids; Non significant ($p>0.05$); Significant ($p<0.05$). Means of triplicate experiment; means with same letters in columns are statistically non significant by Tuckey's T-Test at 0.05 level of significance. (T_0) Control without any addition of MOLP; (T_1) 1% MOLP; (T_2) 2% MOLP; (T_3) 3% MOLP

Table-2 Effect of MOLP fortification on minerals of fortified butter milk

Treatments	Calcium	Potassium	Phosphorous	Iron
	mg/100 grams			
T_0	117.22±1.10d	149.76±0.24	86.36±1.13	0.03±0.01
T_1	135.58±3.46c	160.34±0.83	88.13±0.92	2.88±0.04
T_2	154.46±1.99b	177.75±0.71	88.63±0.22	5.46±0.00
T_3	174.34±2.46a	184.53±1.24	89.76±0.53	6.77±0.00

Non significant ($p>0.05$), Significant ($p<0.05$). Means of triplicate experiment; means with same letters in columns are statistically non significant by tuckey's T-test at 0.05 level of significance. (T_0) Control without any addition of MOLP; (T_1)1% MOLP; (T_2) 2% MOLP; (T_3) 3% MOLP

Minerals and vitamins content: Table 2 presented the results of mineral content of *Moringa oleifera* fortified butter milk. Fortification of *Moringa oleifera* at all levels significantly increased the calcium, potassium and iron content of the fortified butter. The increase in mineral content of the fortified butter milk samples was due to the presence of higher concentrations of these constituents in the dried leaves of *Moringa oleifera*. Iron content of T_3 increased from 0.03-6.77 mg/100 gram. *Moringa oleifera* has been designated as the best plant source to confer high quality protein, appreciable amounts of calcium, iron and carotenoids (Fahey, 2005). Ramachandran *et al*. (1980) studied the nutritional potential of dry leaves of *Moringa oleifera* and reported that consuming 25 grams dry leaves on daily basis can provide 42% protein, calcium 125%, magnesium 61%, iron 71%, vitamin A 272% and vitamin c 272% of the recommended daily allowance of these nutrients. Vitamin content of the fortified butter milk significantly ($p<0.05$) increased by increasing the augmentation level. Vitamin C, B_1, B_2 and B_3 increased by 168, 233, 393 and 625% respectively. The increase in vitamin content was due to the presence of higher concentrations of these vitamins in the dry leaves of *Moringa oleifera*. Fuglie (1999) reported that *Moringa oleifera* leaves contained more vitamin A than carrots, more calcium than milk, more vitamin C than oranges, more potassium than banana and quality of protein is almost similar to eggs, milk and meat. 10 and 15 mg iron is required on daily basis to growing children nursing women. Thus 250 mL of fortified butter milk at T_3 level can provide 16.62 mg iron on daily basis (100% requirement of nursing women) and children's requirement (100%) of ironcan be fulfilled by drinking 150 mL of the fortified butter milk. Fortification with dry leaves of *Moringa oleifera* can resolve the problem of iron deficiency in 60% women and 40% children of Pakistan. The recommended daily allowance of vitamin B_2 is 0.8 and 1.8 mg for children and nursing women, 250 mL of fortified butter milk can meet body's 100% requirement with respect to this vitamin. Quarcoo (2008) studied the impact of *Moringa oleifera* fortification in the beverages containing carrot and pineapple juices and reported that addition of *Moringa oleifera* increased the concentration of pro vitamin A to 6.4 gram per gram. Many practices for the correction of malnutrition in Pakistan have been practiced with the help of many donating and child caring agencies, but the story was not very successful, the most common strategy was the use of vitamins and minerals supplements, many people can not afford these supplements others who consumed were probably least cured from malnutrition. The possible cause for this failure was due to the high ambient temperature (40-50°C) for eight months of the year and vitamins and minerals supplements loose their efficacy when stored in the open shop at high temperature for long time, this problem was further deteriorated by worst load shedding. In this situation this is the best, simple, economical and most efficient method for the correction and prevention of malnutrition.

Sensory evaluation: The results of sensory evaluation are product values of color, taste, texture and overall acceptability as adjudged by a panel of 75 female judges of different villages of Lahore. It is evident from the results of sensory evaluation that addition of dry leaves of *Moringa oleifera* at T_2 level did not have any significant effect ($p>0.05$) on color, taste and overall acceptability scores. As the concentration of dry leaves of *Moringa oleifera* was increased to T_3 level in the fortified butter milk score for color, taste and overall acceptability was significantly ($p<0.05$) decreased. At T_3 level fortified butter milk was slightly missing the sharp fermented taste which could be the reason for low taste

Table 3: Effect of MOLP fortification on vitamins of fortified butter milk

Treatments	Vitamin C	Vitamin B_1	Vitamin B_2	Vitamin B_3
	mg/100 grams			
T_0	0.32±0.06d	0.03±0.01d	0.15±0.03d	0.04±0.01d
T_1	0.49±0.10c	0.05±0.01c	0.35±0.07c	0.12±0.03c
T_2	0.68±0.13b	0.08±0.03b	0.53±0.14b	0.22±0.02b
T_3	0.86±0.17a	0.10±0.02a	0.74±0.12a	0.29±0.06a

Non significant ($p>0.05$); Significant ($p<0.05$).Means of triplicate experiment; means with same letters in columns are statistically non significant by tuckey's T-test at 0.05 level of significance. (T_0) Control without any addition of MOLP; (T_1) 1% MOLP; (T_2) 2% MOLP; (T_3) 3% MOLP

Table 4: Effect of MOLP on sensory evaluation of fortified butter milk

Treatments	Color	Taste	Texture	OA
T_0	7.8±0.23a	8.2±0.19a	7.6±0.05a	7.5±0.13a
T_1	7.6±0.08a	8.0±0.32a	7.3±0.11a	7.4±0.11a
T_2	7.4±0.11a	7.9±0.14a	6.9±0.08b	7.2±0.08a
T_3	6.5±0.09c	7.5±0.07b	6.4±0.17c	6.7±0.05b

Non significant ($p>0.05$); Significant ($p<0.05$); n = 75. Means of triplicate experiment; means with same letters in columns are statistically non significant by tuckey's T-test at 0.05 level of significance. (T_0) Control without any addition of MOLP; (T_1) 1% MOLP; (T_2) 2% MOLP; (T_3) 3% MOLP. OA = Overall Acceptability

score of T_3. Texture score of T_1 and T_0 were non significantly influenced from each other. Texture score decreased significantly at T_2 level, at higher augmentation level of dry leaves of *Moringa oleifera* resulted more fiber in the fortified butter milk which settle down at the bottom and the samples were shaken well before sensory evaluation. The problem of phase separation of fibrous and watery phase could have been avoided by the homogenization of the samples. Level of criticism for T_3 was not adverse as the people are already use to of adding green leaves of coriander and other herbs in the butter milk. The overall acceptability score of T_3 was 6.7 out of 9 which was more than 74%. Quarcoo (2008) studied the development of *Moringa oleifera* based beverage and reported that addition of increasing concentration of *Moringa oleifera* tended to make the color greener and decreased the color score. The low color score was attributed to the uncommon green color of beverage; the lower concentrations were rated higher for this parameter and the decline in taste score was observed with the increasing level of *Moringa oleifera*.

Conclusion The main objective of this research work was to develop fortified butter milk from *Moringa oleifera* and butter milk blends. It is evident from the results that addition of dry leaves of *Moringa oleifera* increased the protein, ash, total solids, calcium, iron and vitamins of B-group. Addition of dry leaves of *Moringa oleifera* at T_2 level did not significantly alter the color, taste and overall acceptability scores. The lowest overall acceptability score obtained by T_3 was 6.7 out of 9 which was more than 74%. Hence fortified butter milk can be made by blending butte milk with dry leaves of *Moringa oleifera* up to 3% level with satisfactory sensory attributes.

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