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Protein and Calcium Rich Malted Health Drink Power

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Abstract

A health drink powder has been developed from malted finger millet (*Eleusine coracana*), various combinations of pulses and skim milk powder. Compare to other health drinks available in market, it has very high content of protein (25.01%) and calcium (Ca-1018.7 mg/100 g). The nutritional content was sufficient to meet day to day nutritional requirements as a supplement. Result of sensory analysis data showed that it has higher acceptability among people and also it is a cost effective product.

Keywords: Pulse (legumes); Skim milk powder; Malting; Hunter colour-lab

Introduction

The plant foods are considered vital to our survival and nearly 70% of food proteins and more than 80% of food energy requirements are supplied by the plants and cereal grains are in the majority to fulfill these requirements [1]. In third-world countries, a requirement of high nutrient foods is for lactating women, hard-working people and pre-school children are the biggest challenge of the current time and to make available them in the market at economical price and also in the most acceptable form.

The daily calcium requirement for adults is 800-1200 mg. It has been found that sufficient quantity of calcium intake protects against osteoporosis, colon cancer and kidney stone and also helps to control blood-lipid levels. The optimum ratio of calcium to protein is necessary for bone gain in children. Normally, 16:1 (mg:g) is good for human health [2]. Protein-energy malnutrition is a common syndrome in India which occurs during the weaning phase of a child's life [3] and also in the case of pregnant and the lactating women. Furthermore, diabetes is a major disorder that increases among different age groups and in India it was 19 million in the year 1995 which increased to 25 million in 2007 and by 2025 it would reach up to 57 million [4]. Cereals are prime targets in this regard. As dietary staples, relatively small improvements in grain composition (especially in starch and fibre) have the potential to translate into significant health gains at the population level when they are incorporated into food [5]. Millets are one of such kind of the cereal. Millet is a cereal crop plant belonging to the grass family, Graminae [6]. They are an oldest food known to human and possibly the first cereal grain to be used for domestic purpose. In Indian civilization, it is also mentioned in *brihad sanhita*. Millets are highly nutritious, non-glutinous, non-acid forming, least allergenic and most digestible available grains. Hence, it is also called as "nutri-cereals". Various types of millets are cultivated in the world. Among these, finger millet (*Eleusine coracana*) is the most widely grown millet in India. Finger millet is originally native to Ethiopian highlands and was introduced in India 4000 years ago [7]. In year 2007, production of finger millet round the world is 4.5 million tons in which only India accounts for 10,610,000 tons [8]. It contains 7.7% protein, 1.5% fat, 2.6% minerals, 3.6% fibre, 72.6% carbohydrate and its 100g of seeds contains 350 mg of calcium, 283 mg of phosphorus, 3.9 mg of iron, 0.19 mg of riboflavin, 1.1 mg of niacin and 0.42 mg of thiamin [9]. Some of the known health benefits associated with the finger mil let, such as its hypoglycemic [10], hypo-cholestrolemic characteristics [11], anti-ulcerative properties and anti- microbial properties [12] along with above therapeutic values it has also longer storage quality [13].

Finger millet malt was highly acceptable sensory profile among all the millets [14,15] and also malting further increases its protein utilization and calcium content [16]. Pulses are the major source of protein of the human dietary system. Pulses and cereals constitute an important source of dietary calories and proteins for much of the world's population, especially in developing countries. Domestic processing, such as malting and roasting, has been shown to reduce the levels of phytic acid [17,18], saponins [19] and polyphenols [20] in legumes and due to reduction of anti-nutritional factors, the total nutrition utilization of the legumes in the human body is increases. Milk and milk products are the good source of protein, fat, lactose and essential minerals including calcium. The combination of lysine-rich milk protein with lysine deficient cereals delivers the synergistic effect, which imparts a high nutritional value to the mixed protein in the products [21] and also milk & milk products enhance the sensory profile of foods which leads to increase its the acceptability among consumers.

To develop a product that can be able to meet the daily requirements of nutrition by supplementation as well as beneficial for excellent health is requirement of current era. Therefore, developing a health drink powder based on finger millet, milk and pulses to fulfill above discussed requirements for human health will be very good option. Such a formulation which could be stored for longer time as well as used even in those areas where the liquid milk is not easily available.

The study was conducted with the following objectives:

1. To develop protein and calcium rich malted health drink powder (PCMHDP).

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2. To evaluate the PCMHDP in terms of chemical composition and sensory profile.

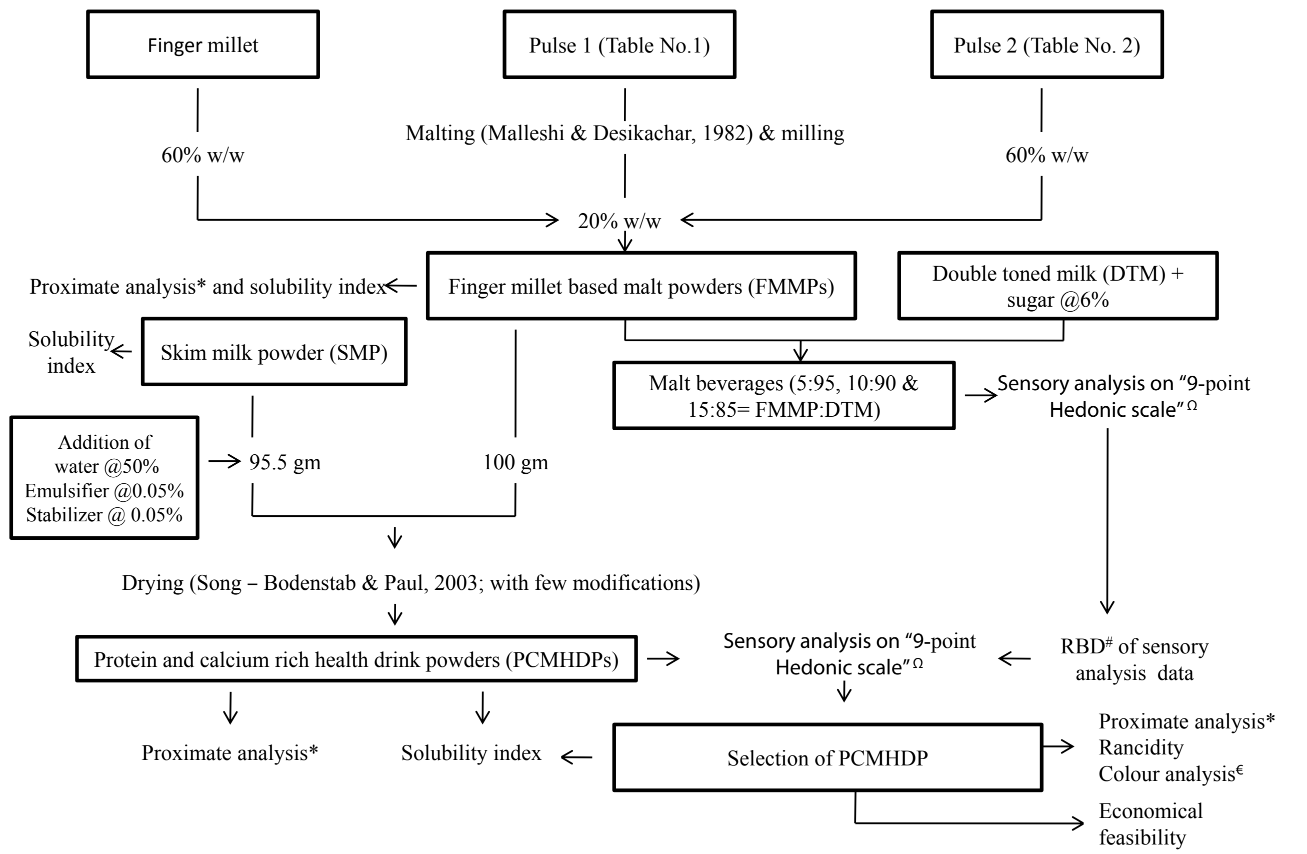
3. To calculate techno-economical feasibility PCMHDP.

Materials and Methods

Raw materials which were used for development of PCMHDP were good quality of Finger millet, skim milk powder (SMP), pulses, emulsifier and stabilizer were purchased from the local market of Raipur, India.

Preparation of finger millet based malt powder (FMMP)

In order to develop PCMHDP, finger millet was mixed with the pulses. Due to this combination, the protein content had been increased by several folds. Finger millet was mixed with two different types of pulses at a time to obtain a synergetic effect. Various types of combinations were made to figure out best one in terms of both sensory and nutritional aspects (Figure 1). The best suitable combinations according to requirement were made and showed in tables 1 and 2.



*=Moisture, protein, fat, ash, carbohydrate and calcium; €=by colour flex 'Hunter Lab", Ω =by a panel of 7 judges (Amerine *et al.*,1965)
= Steel and Torrie, 1981, O' Mahoni, 1986

Figure 1: Materials and methods flow-diagram of development of PCMHDR.

Types of FMMP	60% w/w	Pulse 1(20% w/w)	Pulse 2 (20% w/w)
FMMP1		*Phaseolus aureus* Roxb.	*Dolichos uniflorus* Lam.
FMMP2		*Phaseolus aureus* Roxb.	*Phaseolus mungo* L.
FMMP3		*Phaseolus aureus* Roxb.	*Cicer arientinium* L.
FMMP4		*Glycine max* (L.) Merr.	*Lens esculenta* Moench
FMMP5		*Psophocarpus tetragonolobus* (L.) DC.	*Dolichos uniflorus* Lam.
FMMP6	*Eleusine coracana*	*Cicer arientinium* L.	*Phaseolus aconitifolius* Jacq.
FMMP7		*Psophocarpus tetragonolobus* (L.) DC.	*Pisum sativum* L.
FMMP8		*Dolichos uniflorus* Lam.	*Vigna unguiculata* (L.) Walp.
FMMP9		*Phaseolus mungo* L.	*Pisum sativum* L.
FMMP10		*Phaseolus aureus* Roxb.	*Lens esculenta* Moench
FMMP11		*Glycine max* (L.) Merr.	*Phaseolus aconitifolius* Jacq.

Table 1: Combinations of FMMPs.

Results

The chemical composition of the Skim Milk Powder (SMP) and FMMPs were determined to keep observation on the quality of raw materials so that best possible quality of standard PCMHDPs could be prepared. The proximate analysis results of FMMPs were shown in table 3.

FMMPs were mixed with the double toned milk (DTM) at room temperature and a constant amount of sugar, which was @ 6% was added after that it was boiled on medium flame to prepare 3 different concentrations of malt beverages from each type of FMMPs. The different blends of finger millet based malt powders and DTM, which were used to prepare malt beverages were 5:95, 10:90 and 15:85 (FMMP: DTM), they were represented as T_1, T_2 and T_3 respectively. The selection of the most acceptable malt beverage was done based on the sensory analysis result which was based on the scores of 7 expert judges with help of 9-point "*Hedonic scale*". On the basis of sensory test results, it was found that the T_2 was the most acceptable combination. The average sensory score card of the T_2 was given below in the table 4.

An attempt was done in present investigation to develop a standard product by using FMMP and skim milk powder. By the reverse calculation method, the optimum amount of FMMP and milk solids was calculated for the most acceptable blend of malt beverage. In order to develop PCMHDP, 100g FMMP; 95.5 g of SMP, Luke warm water @ 50%, Stabilizer @ 0.5% and emulsifier @ 0.5% were taken before drying. The drying was done as the process suggested by Song-Bodenstab and Paul [22] with few modifications in order to improve the solubility and sensory profile of PCMHDPs. The chemical composition of finally developed PCMHDPs was shown in table 5.

On the basis of sensory score card given by the panel of 7 judges on "*9-point Hedonic Scale*" the most acceptable composition of PCMHDP was selected. The sensory score data was given in figure 2.

The solubility of the finally developed and selected PCMHDP was analyzed by the method described in the F.A.O. manuals of Food Quality Control 14/ 8 page 31/ British standard 1743: Part 2 : 1980. The averages values of solubility of different powders were given in the table 6.

Colour analysis of selected PCMHDP

The variation in colour from one product to another is a natural phenomenon. The colour of the product was measured by the "*Hunter-lab*". The Hunter colour scale (L, a and b) evolved during the 1950s and 1960s. At that time many of the scientists involved with colour measurement were working with colour scales that took quite a lot of effort and understanding to interpret but these scales did not visually relate to what the human saw and made it difficult for organizations to set a standard to work to.

Mr. Richard Hunter invented the L, a, b colour scale that took the theory that we don't just "see" colour but we can also talk about how light or dark the object is.

For better representation of colour measurement is shown in terms of L, a and b values while the total Hunter lab colour was represented as E (Where, $E = \{(L)^2 + (a)^2 + (b)^2\}^{½}$).

+L means the sample is whiter/ brighter side, -L means the sample is darker/blackish side, +a means the sample is redder side, - a means the sample is greener side, +b means the sample is yellowish side and -b means the sample is bluer side. The colour analysis data was shown in table 7.

Techno-economical feasibility of PCMHDP

Note:

- Inventory Theory's model III is applied which states that economic lot size model with uniform rate of demand, finite rate of replenishment having no shortages. (Including the basic theory of Inventory Theory)
- Assumptions: All the assumptions should be made for the production of PCMHDP at minimum level,
- Set up cost was assumed on ground reality basis at minimum level.

Test	Book	Method No.
Moisture	A.O.A.C. manual (1995)	977.11
Protein	A.O.A.C. manual (1995)	976.06 (micro-kjeldhal)
Total fat	A.O.A.C. manual (1995)	920.39C (Soxhlet method using "Socs-Plus")
Ash	A.O.A.C. manual (1995)	900.02A
Carbohydrate	A.O.A.C. manual (1995)	By-difference method
Solubility	F.A.O. manual of Food Q. C.	British standard 1743: Part 2 : 1980
Total Calcium	A.O.A.C. manual (1995)	984.27

Table 2: Analytical procedures for proximate analysis.

Type of FMMP	Moisture (%)	Protein (%)	Fat (%)	Ash (%)	Carbohydrate (%)	Calcium (mg/100g)
FMMP1	9.24	14.20	0.81	3.62	72.13	382.32
FMMP2	9.21	14.51	0.95	3.16	72.17	346.15
FMMP3	9.20	14.16	1.49	2.93	72.22	323.31
FMMP4	9.21	17.50	3.25	3.3	66.74	347.41
FMMP5	9.20	15.35	2.73	3.65	69.07	459.68
FMMP6	9.25	13.58	1.48	2.97	72.72	341.13
FMMP7	9.21	14.84	2.79	3.01	70.15	393.12
FMMP8	9.20	13.95	0.81	3.49	72.55	376.81
FMMP9	9.23	14.33	0.99	3.19	72.26	345.16
FMMP10	9.22	14.98	0.86	2.97	71.97	310.98
FMMP11	9.21	17.08	3.24	3.48	66.99	384.34

Table 3: Chemical composition of FMMPs.

S. No.	Particular	Average Score
	Appearance & colour	6.8
	Flavour	7.6
	Mouth feel	7.9
	Over all acceptance	7.43

Table 4: Average sensory score of blend T2 (10:90::FMMP: DTM).

Type of FMMP	Moisture (%)	Protein (%)	Fat (%)	Ash (%)	Carbohydrate (%)	Calcium (mg/100g)
PCMHDP1	3.98	25.03	1.05	5.39	64.55	1049.94
PCMHDP2	3.99	25.19	1.13	5.15	64.54	1030.79
PCMHDP3	3.98	25.01	1.42	5.03	64.56	1018.7
PCMHDP4	3.98	26.79	2.37	5.23	61.63	1031.46
PCMHDP5	3.98	25.65	2.09	5.41	62.87	1090.88
PCMHDP6	3.98	24.71	1.41	5.05	64.85	1028.13
PCMHDP7	3.98	25.37	2.12	5.07	63.46	1055.65
PCMHDP8	3.98	24.89	1.05	5.33	64.75	1047.02
PCMHDP9	3.99	25.10	1.15	5.17	64.59	1030.27
PCMHDP10	3.98	25.45	1.08	5.05	64.44	1012.17
PCMHDP11	3.98	26.57	2.36	5.32	61.77	1050.86

Table 5: Chemical composition of the PCMHDP.

Discussion

Composition of FMMPs

The malt powder of similar composition was not yet prepared. From the table 3, it was clearly observed that FMMPs were rich source of protein, ash and calcium while their fat content is quite low. This is due to two main reasons; first, for the presence of malted finger millet powder 60% (w/w) which is the richest source of calcium among all the cereals, and its fat content is quite low. Second, the total malted pulse powder content in FMMPs is 40% (w/w) which are rich in protein and ash; their fat content is low.

Selection of most acceptable blend of FMMPs beverages

In absence of similar literatures the above result cannot be compared with some other data. RBD was applied on the sensory data of table 4, it was found that appearance & colour and flavour scores were non-significant but the scores of mouth feel and overall acceptability were significant for 10:90=FMMPs: DTM at the level of 5% of significance. The main driving force for outcome of this result is due to variation in concentration of FMMPs in the beverages. The 5% concentration's blend leads to slightly higher fluidity in the beverage while 15% was highly viscous in nature. The 10% concentration's blend had normal viscosity.

Development of the ready-to-serve PCMHDPs

US patent no.6541056 [22], claimed that by using its process the solubility of malted milk powder can be increased up to 85% and its sensory characteristics will be also similar to the products which are available in the market. This process was used in current research for the formulation of final product with few modifications.

The process not only increases the solubility of finally developed product than the solubility of same composition of the untreated mixture of raw materials but also enhances the sensory profile of the developed product. In the absence of this kind of work on finger millet, the above results cannot be discussed with other data. The finally developed PCMHDPs contained fairly high amount of protein (24.71-26.79%), ash (5.03-5.41%) and 1012.17-1090.88 (mg/100 g) calcium, which shows that PCMHDPs was nutritionally rich, especially in terms of calcium and protein. The presence of calcium is nearly 20% of the total amount of the ash available in the PCMHDPs.

Selection of PCMHDP

On the basis of sensory data of figure 2, the most acceptable PCMHDP was selected (RBD analysis). Statistically, it was found that appearance and colour and flavour scores were non-significant at the level of 5% while the scores of mouth feel and overall acceptability were significant for PCMHDP. The main reason behind it might be the better sensory profile of *Phaseolus aureus* Roxb. and *Cicer arientinium* L. than the other pulses.

Solubility of PCMHDP

As per the *US patent no.6541056*, solubility of the finally developed product will be increased than the untreated mixture of raw materials of the same composition. It is found that although the solubility of SMP is 98.93%, which is quite higher than the solubility of the final product (85.73%) but using newly modified version of processing in current research (*US patent no. 6541056;* with few modifications) leads to increase in solubility than the untreated malt powder and SMP mixture (65.76%). The total solubility after this treatment was increased by 30.37%.

Colour analysis

Lorenz and Dilsaver [23] did the colour measurement of the milled proso millet flour. Due to variation in the ratio of an amount of wheat and proso millet, it was found that variation in colour was occurred, which was represented as Hunter colour difference meter. Due to the absence similar literature, no colour data were available for the comparison of current research.

As shown in the table 7, it was observed that selected PCMHDP had brighter tint (higher+L value) and due to its positive a and b values; it had a brownish-white colour.

S. No.	Material	Solubility (% w/w)
	FMMP	36.05
	Skim milk powder (SMP)	98.93
	FMMP + SMP	65.76
	Developed & selected PCMHDP	85.73

Table 6: Solubility of the raw materials, their combination and developed product.

	L	a	b	E
PCMHDP	77.83	3.44	11.98	78.82

Table 7: Colour analysis data and rancidity of freshly prepared PCMHDP.

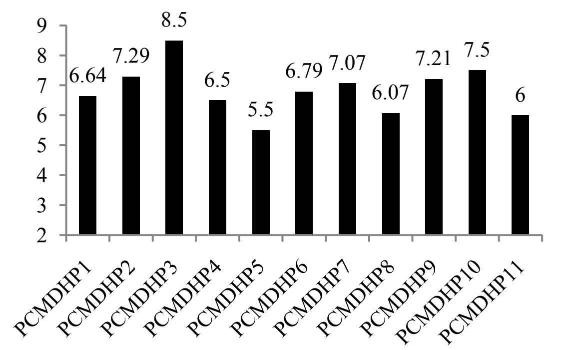


Figure 2: Average score card of overall acceptability of different PCMHDPs.

Heads	Rs./kg	Quantity used (kg/ 100kg)	Total Rs.
I. Expenditure			
a) Raw material			
Skim mlik powder	180	48.80	8784.00
Eleusine coracana	16	30.66	490.56
Phaseolus aureus Roxb.	70	10.22	715.40
Cicer arientinium L.	50	10.22	511.00
Emulsifier & stabilizer	200	0.1	20
Sub-total	-		***10520.96***
b) Processing cost @ 15 per cent of raw materials cost			***1578.14***
II. Handling cost excluding raw materials, packaging and processing			***2000***
***Set up cost @7.0%* (daily basis)**			255.70
Total Production Cost of PCMHDP / 100kg			***14354.80***

Table 8: Production cost of PCMHDP.

Techno-economical feasibility

In the absence of similar work, its techno-economical feasibility cannot be compared. As shown in table 8, production cost of PCMHDP was approximately Rs. 143.55. If we compared it with other health drink powder present in market then it was more economical and also had very high nutritional values; especially in terms of protein and calcium content.

Conclusion

This developed PCMHDP's protein content was around 5 times while calcium was 2 times higher than similar products available in the market. This product has highly acceptable sensory values even without any addition of either of natural or artificial colour and falvour.

Suggestions for future research work

1. Selection of proper packaging material for PCMHDP.
2. Estimation of shelf-life of PCMHDP.
3. In vivo studies (on animals and human).
4. Addition of flavour and colour in the PCMDHP.
5. Micro- nutrient analysis for exact nutritional values of the PCMDHP.

References

1. FAO (2002) FAO production year book. Food and Agriculture Organisation of the United Nations Statistics series No. 106, Rome.
2. Patel RS, Renz - Schauen A (1998) Dietary calcium and its role in disease prevention. Indian Dairyman 10: 49-51.
3. Malleshi NG, Desikachar HSR (1982) Formulation of a weaning food with low hot paste viscosity based on malted ragi (Eleusine coracana) and green gram (Phaseolus radiatus). J Food Sci Technol 19: 193-197.
4. India Today (2009) Assesed on June 17th 2010.
5. Regina A, Bird AR, Li Z, Rahman S, Mann G, et al. (2007) Bioengineering cereal carbohydrates to improve human health. Cereal Foods World 52: 182-187.
6. FAO (1995) Sorghum and millets in human nutrition. FAO, Food and Nutrition series. Rome, Italy.
7. Butler EA (1999) Traditional seed cropping systems in the temperate Old World: Models for Antiquity? In (C. Gosden and J.G. Hather, eds). Change in Subsistence Systems: Social Theory and Biological Processes. London: Routledge.
8. Food and Agriculture Organization (FAO) (2008) Viewed on 30 January 2010.
9. Hulse JH, Laing EM, Pearson OE (1980) Sorghum and the millets: their composition and nutritive value. Academic Press.
10. Laxmi Kumari P, Sumathi S (2002) Effect of consumption of finger millet on hyperglycemia in non-insulin dependent diabetes mellitus (NIDDM) subjects. Plant Foods Hum Nutr 57: 205-213.
11. Hegde P, Chandrakasan G, Chandra T (2002) Inhibition of collagen glycation and crosslinking in vitro by methanolic extracts of Finger millet (Eleusine coracana) and Kodo millet (Paspalum scrobiculatum). J Nutr Biochem 13: 517.
12. Es-Safi, N.E.; Josiane, B. Christine Le, G. and Paul-Henri, D (2007) Synthesis and Antioxidant Activity of Modified (+)-Catechin Derivatives. Structure-Activity Relationship. Am J Food Technol 2: 618-629.
13. Iyengar KG, Doraisami LS, Iyengar RS (1945) Ragi (*Eleusine coracana*). Mysore Journal of Agricultural Sciences 24: 33.
14. ICAR (1961) Finger millet and other small millets. ICAR, New Delhi.
15. Malleshi NG, Desikachar HRS, Tharanathan RN (1986) Physico-chemical Properties of Native and Malted Finger Millet, Pearl Millet and Foxtail Millet Starches. Starch - Stärke 38: 202-205.
16. Desai AD, Kulkarni SS, Ranveer RC, Dandge PB, Sahoo AK (2010) Effect of Supplementation of Malted Ragi Flour on the Nutritional and Sensorial Quality Characteristics of Cake. Advance Journal of Food Science & Technology 2: 67-71.
17. Khokhar S, Chauhan BM (1986) Nutrient composition, protein fraction and antinutritional factors of moth bean (Vigna aconitifolia). Bull Grain Technol 24: 3.
18. Kataria A, Chauhan BM, Gandhi S (1988) Effect of domestic processing and cooking on the antinutrients of black gram. Food Chem 30: 149-156.
19. Jood S, Chauhan BM, Kapoor AC (1986) Saponin content of chickpea and black gram: Varietal differences and effects of processing and cooking methods. J Food Sci Agric 37: 1121-1124.
20. Jood S, Chauhan BM, Kapoor AC (1987) Ployphenols of chickpea and blackgram as affected by domestic processing and cooking methods. J Sci Food Agric 39: 145-149.
21. Rajorhia GS (2000) Modernization of traditional Indian dairy products and improving their quality. Indian Dairyman 52: 9-15.
22. Song-bodenstab X, Paul E (2003) Malt Powder Manufacturing Process. *US Patent no. 6541056.*
23. Lorenz K, Dilsaver W, Bates L (1980) Proso millets. Milling characteristics, proximate composition, nutritive value of flours. Cereal Chem 57: 16-20.