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Storage Studies of Developed Whey Based Porridge Enriched with Caseinophosphopeptides

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A B S T R A C T

The investigation was aimed to develop a whey based porridge rich in calcium and iron using finger millet and pearl millet flour at the level of 10, 20 and 30% concentration. The sugar was partially substituted by stevia with different combinations of sugar: stevia respectively at 8 per cent level to the whey porridge. Incorporation of finger millet flour at 30% and pearl millet flour at 20% concentration and 25:75 combination of sugar: stevia were scored maximum organoleptic scores. Whey porridge was incorporated with caseinophosphopeptides at various levels of 2, 3 and 4 per cent and 2 per cent was found to be acceptable. The final optimised whey porridge samples were stored at ambient and refrigeration temperature in different packaging materials polyethylene, polystyrene, polypropylene and polyethylene teraphthalate cups. Product packed in polyethylene teraphthalate had secured highest acceptability and had shelf life of 3 days at room temperature and 10 days at refrigeration temperature without affecting sensory attributes.

Introduction

Milk and milk products are considered as important source of calcium, protein, potassium and phosphorus. They contribute around 52-65 per cent of the dietary reference intake of calcium and 20-28 per cent of the protein requirement. The excellence of milk as a source of calcium is not only due to its high calcium content but also due to the bioavailability of this mineral. Some cereals even though contain high amount of calcium its bio-availability is less, possibly because the major portion of this mineral is in bound state. Millets are major food source and source of energy especially protein for millions of people in arid and semiarid parts of the world because of their ability to grow

under adverse weather conditions like limited rainfall. It has been reported that millet has many nutritious functions. The term "Millet" (Nutritional Crop) is applied to various grass crops whose seeds are harvested for human food or animal feed. Millets are excellent sources of carbohydrates, protein, fatty acids, minerals, vitamins, dietary fiber and polyphenols (Thapliyal *et al.*, 2015).

Among millet crops, finger millet figures prominently; in world it ranks fourth in importance after sorghum, pearl millet and foxtail millet. In India, finger millet occupies the largest area under cultivation among the small millets. Finger millet stands unique among the cereals such as barley, rye and oats with higher nutritional contents and has outstanding properties as a subsistence food crop.

Pearl millet has high nutritional value in terms of high levels of energy, dietary fibre and proteins with a balanced amino acid profile, many essential minerals, some vitamins and antioxidants. These play a significant role in prevention of important human ailments such as diabetes, cancer, cardiovascular and neurodegenerative diseases.

There is great potential for harnessing these positive attributes through genetic improvement, improved crop management, and grain processing and food products technologies. These should help to develop greater global awareness of the importance of this crop for food and nutritional security (Singhal *et al.*, 2018).

Stevia rebaudiana is a nutrient rich natural sweetest plant of *Asteraceae* family. The leaves naturally contain diterpene glycosides stevioside, rebaudiosides A-F, steviolbioside and dulcoside, which are responsible for its sweet taste and have commercial value all over the world as sugar substitute in foods, beverages or medicines.

Stevia has many pharmacological and therapeutic applications as suggested by many preclinical and some clinical studies; these are nontoxic and possess antioxidant, antimicrobial, antifungal and anticarcinogenic activity. In future *Stevia* is likely to become a major source of high potency low calorie sweetener for growing natural food market (Gupta *et al.*, 2013). Bio-active peptides derived from the enzymatic digestion of casein; known as caseinophosphopeptides (CPPs), possess physico-chemical properties that enhance mineral solubility in the lower small intestine.

These CPPs have been shown to bind macro elements such as calcium, magnesium and iron along with the trace elements like zinc, barium, chromium, nickle, cobalt and selenium (Arunachalam and Raja, 2010). CPP also has been researched in the areas of sports medicine, anti-hypertensive medicine, remineralisation, immunoenhancement and immunomodulation. CPP has the 4 potential of becoming a food based nutritional item and boosting the immune system of humans (Arunachalam and Raja, 2011).

Caseinophosphopeptides, as the name suggests, are casein-derived peptides that have phosphorus bound *via* monoester linkages to seryl residues. The term appears to have been introduced by Mellander (1950) to describe a group of phosphorylated casein peptides that enhanced bone calcification independently of vitamin D in rachitic children. Due to their highly negatively charged structures arising from phosphorylation, CPPs have the ability to bind a range of macro elements such as calcium, magnesium and iron, and trace elements such as zinc, barium, chromium, nickel, cobalt and selenium (Fitz Gerald, 1998).

Materials and Methods

Paneer whey was used from Students Experimental Dairy Plant (SEDP), Dairy Science College, Hebbal, Bangalore. Good quality cane sugar was procured from the local market in Bengaluru. The fresh ragi malt was prepared at laboratory of Dairy Science College, Bengaluru, in a clean and Hygienic condition as per Desai *et al.*, (2012) with slight modifications for the preparation of bioactive nutraceutical whey porridge. The fresh pearl millet

malt was prepared at laboratory of Dairy Science College, Bengaluru, in a clean and hygienic condition as per Badau *et al.,* (2005) with slight modifications for the preparation of bioactive nutraceutical whey porridge. Stevia was used as a bio sweetener to replace sugar procured from the outlet of Stevia world in Bengaluru. Packaging material such as Polyethylene teraphthalate (PET) jars of standard size 100 ml were used for packaging of the whey porridge and dry blend of the ingredients required for preparation of whey porridge which was procured from Grace International, Valiv Vasai, Thane.

Preparation of control whey porridge

Control porridge was prepared by incorporation of finger millet flour at the rate of 20% and sugar at the rate of 8%.

Development of whey based porridge

Clear whey was obtained by the paneer prepared as per the procedure given by Arunkumar (2006), with slight modifications. Clarified whey was pasteurized at 90°C/ no hold and then cooled to 37°C. Combination of malted finger millet and pearl millet flours are added to the whey slowly at different levels i.e., 10%, 20% and 30% and stirred continuously in order to avoid lumps formation. Sugar replacement was tried with bio sweetener, Stevia with partial replacement of sugar at 50:50, 25:75 or 0:100. It was also tried by complete replacement of sugar at 2, 4 or 6 per cent of stevia and stirred continuously. Then the whole mixture was heated to 75°C for 5 min and cooled to room temperature. The final product was packed in Polyethylene teraphthalate (PET) jars and stored in refrigeration temperature.

Determination of compositional parameters

Standard procedure of ISI: SP 18 (Part XI) 1981 was adopted for carrying out chemical analysis such as fat, total solids, titratable acidity determination while pH was measured in digital pH meter at 25°C.

Sensory evaluation

Whey porridge samples were given to a panel of five judges for sensory evaluation. Each judge was supplied with standard score card of a total of 9 Point Hedonic Scale (Annexure-1) for colour and appearance, body and texture, flavor and overall acceptability. The scores given by panel of judges were then statistically analyzed. The samples were code numbered to avoid identification and bias.

Statistical analysis

The data was analyzed using R software {R Programme, R-Version 3.1.3(2015-3-09), Copyright © 2015} both one way and two way Completely Randomed Design (CRD) which is the most appropriate for the study.

Results and Discussion

Effect of different packaging materials on the sensory quality and shelf life of bioactive nutraceutical whey porridge stored at room temperature (30±1˚C)

The control and developed whey porridge samples packed in Polyethylene (C), Polystyrene (P1), Polypropylene (P2) and Polyethylene teraphthalate (P3) cups, were subjected to sensory evaluation, the results obtained for all sensory attributes is tabulated in Table 11.

The sensory scores obtained on the day 1of product storage with respect to colour and appearance for Control, P1, P2 and P3 were 7.93, 7.86, 7.78 and 7.9, respectively. Similarly the sensory scores obtained on day 2 with respect colour and appearance for Control, P1, P2 and P3 were 7.63, 7.53, 7.43 and 7.8, respectively. On day 3 control and P3 obtained 7.26 and 7.63 whereas P1 and P2 were spoiled. On day 4 all were spoiled.

The sensory scores obtained on day 1of product storage with respect to body and texture for Control, P1, P2 and P3 were 8.03, 7.9, 7.9 and 8.1

respectively. Similarly the sensory scores obtained on day 2 with respect body and texture for Control, P1, P2 and P3 were 7.66, 7.46, 7.43 and 7.63 respectively. On day 3 control and P3 obtained 7.49 and 7.52 whereas P1 and P2 were spoiled. All samples were spoiled on day 4.

The sensory scores obtained on day 1 of product storage with respect to flavour for Control, P1, P2 and P3 were 8.13, 8.00, 8.05 and 8.13, respectively. Similarly the sensory scores obtained on day 2 for Control, P1, P2 and P3 were 7.6, 7.43, 7.4 and 7.5, respectively. On day 3 control and P3 secured 7.4 and 7.58, respectively whereas P1 and P2 were spoiled. On day 4 all the samples were unacceptable.

The sensory scores with respect to overall acceptability obtained on day 1 for Control, P1, P2 and P3 were 8.13, 8.00, 8.05 and 8.13, respectively. Similarly on day 2 Control, P1, P2 and P3 secured 7.76, 7.56, 7.46 and 7.8, respectively. On day 3 P1 and P2 were spoiled and 4th day all the samples were unacceptable. Statistical analysis revealed that all samples were significantly different from control.

Effect of different packaging materials on the microbiological quality of bioactive nutraceutical whey porridge stored at room temperature (30±1˚C)

The microbiology quality of whey porridge with respect to coliform and yeast and mold counts were enumerated for both control porridge and developed whey porridge samples at daily interval packed in Polyethylene (C), Polystyrene (P1), Polypropylene (P2) and Polyethylene teraphthalate (P3) cups, during storage at room temperature (30±1˚C). The effect of different packaging materials on the microbial quality of developed whey porridge stored at room temperature (30±1˚C) is tabulated in Table 12.

The coliform and yeast and mold counts were absent in all samples on day 1 and on day 2. On 3rd day P1 and P2 showed yeast and mold count of 0.23 and 0.36 log10 cfu/ml. on 4th day all the samples were found unacceptable due to yeast and mold growth in all the samples. It was observed that there was off-flavour development in these samples, hence they were considered as spoiled.

Effect of different packaging materials on the sensory quality and shelf life of bioactive nutraceutical whey porridge stored at refrigeration temperature (4±1˚C)

Effect of different packaging materials on the sensory quality of developed whey porridge stored at refrigeration temperature 4±1˚C is presented in Table 13. The sensory scores obtained on day 1 with respect to colour and appearance for Control, P1, P2 and P3 were 8.5, 8.26, 8.33 and 8.4, respectively. Similarly the sensory scores obtained on day 4 with respect colour and appearance for Control, P1, P2 and P3 were 8.2, 8.0, 8.05 and 8.23, respectively.

The sensory scores obtained on day 7 with respect colour and appearance for Control, P1, P2 and P3 were 7.8, 7.66, 7.53 and 8.1. On day 10 control and P3 obtained scores of 7.6 and 7.83 whereas P1 and P2 were unacceptable. On day 13, Control and P3 were unacceptable.

The sensory scores obtained on day 1 with respect to body and texture for control, P1, P2 and P3 were 8.5, 8.29, 8.36 and 8.44, respectively. Similarly the sensory scores obtained on day 4 for control, P1, P2 and P3 were 8.19, 8.05, 8.18 and 8.23, respectively.

The sensory scores obtained on day 7 with respect body and texture for Control, P1, P2 and P3 were 7.9, 7.84, 7.77 and 8.00. On day 10 control and P3 obtained scores of 7.73 and 7.85 whereas P1 and P2 were unacceptable. On day 13, control and P3 were unacceptable.

The sensory scores obtained on day 1 with respect to flavour for control, P1, P2 and P3 were 8.56, 8.28, 8.25 and 8.45, respectively. Similarly the sensory scores obtained on day 4 with respect flavour for control, P1, P2 and P3 were 8.23, 8.13, 8.10 and 8.35, respectively.

Table.1 Effect of different packaging materials on the sensory quality and shelf life of bioactive nutraceutical whey porridge stored at room temperature (30±1˚C)

Sample	Colour and Appearance				Body and Texture				Flavour				Overall acceptability			
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
C	7.93^{a}	7.63^{a}	7.26^{a}	Spoiled	8.03^{a}	7.66^{a}	7.49^{a}	Spoiled	8.13^{a}	7.6^{a}	7.40^{a}	Spoiled	8.13^{a}	7.76^{a}	7.72^{a}	Spoiled
P1	7.86^{a}	7.53^{a}	Spoiled		7.9^{a}	7.46^{b}	Spoiled		8.00^{a}	7.43^{b}	Spoiled		7.9^{a}	7.56^{b}	Spoiled	
P2	7.78^{a}	7.43^{a}			7.9^{a}	7.43^{ba}			8.05^{a}	7.4^{b}			7.86^{a}	7.46^{b}		
P3	7.9^{a}	7.8^{abc}	7.63^{b}		8.1^{a}	7.63^{ac}	7.52^{b}		8.13^{a}	7.5^{a}	7.58^{b}		8.13^{a}	7.8^{ac}	7.63^{b}	
CD	NS	0.2	0.25		NS	0.2	0.07		NS	0.11	0.03		NS	0.11	0.01	

Note – All the values are average of three trials

C – Control of porridge packed in Polyethylene cups

P_1 – Developed whey porridge packed in Polystyrene cups

P_2 - Developed whey porridge packed in Polypropylene cups

P_3- Developed whey porridge packed in Polyethylene teraphthalate cups

Table.2 Effect of different packaging material on microbiological quality of developed whey porridge stored at room temperature (30±1˚C).

Storage days log_{10} cfu/ml								
Days	**1**		**2**		3		4	
Sample	Coliforms	Y & M	Coliforms	Y & M	Coliforms	Y & M	Coliforms	Y & M
C	Nil	Nil	Nil	Nil	Nil	Nil	Nil	0.4
P_1	Nil	Nil	Nil	Nil	Nil	0.23	Spoiled	
P_2	Nil	Nil	Nil	Nil	Nil	0.36		
P_3	Nil	Nil	Nil	Nil	Nil	Nil	Nil	0.35

Note – All the values are average of three trials

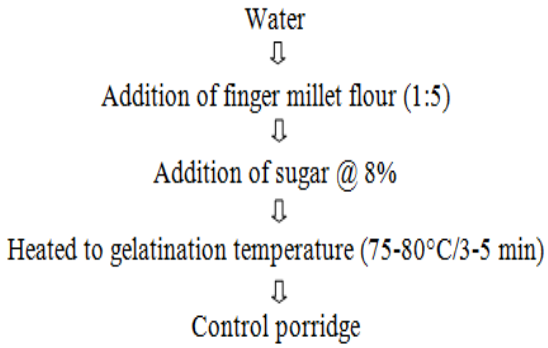
C – Control porridge packed in Polyethylene cups

P_2 - Developed whey porridge packed in Polypropylene cups

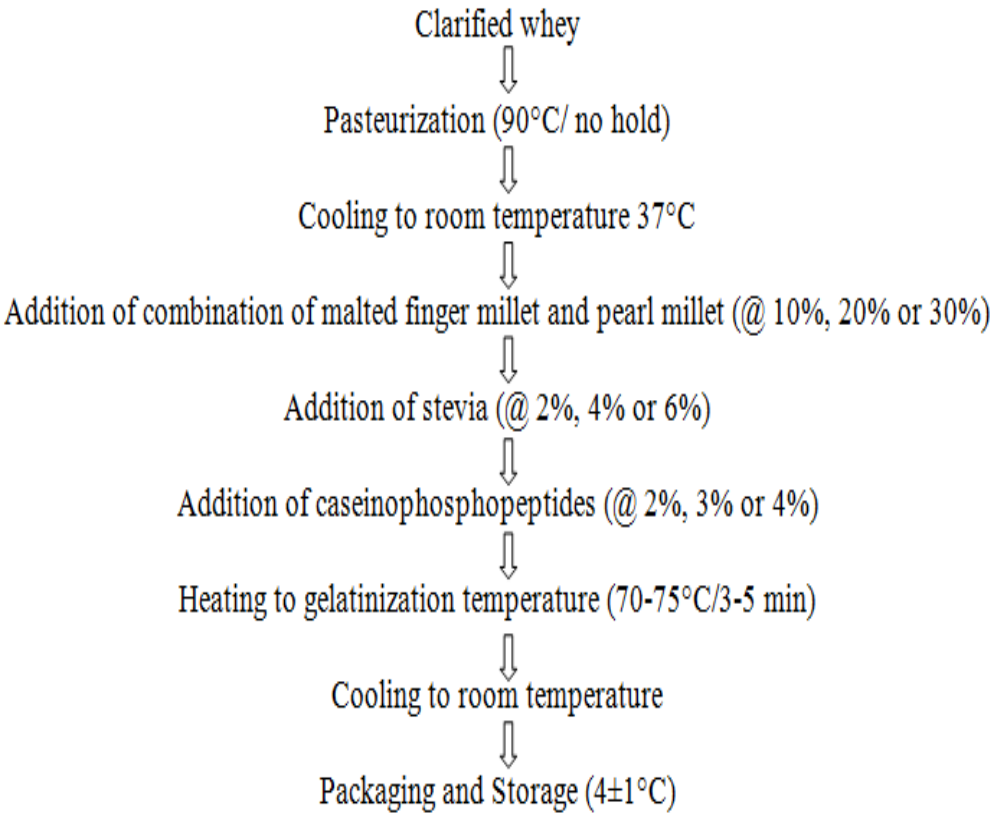
P_1 – Developed whey porridge packed in Polystyrene cups

P_3- Developed whey porridge packed in Polyethylene teraphthalate cups

Flow chart.1 Flow chart for the preparation of control porridge



Flow chart.2 Flowchart for Preparation of nutraceutical whey porridge



The sensory scores obtained on day 7 with respect to flavour for control, P1, P2 and P3 were7.96, 7.84, 7.77 and 8.0. On day 10 control and P3 obtained scores of 7.72 and 7.86 whereas P1 and P2 were unacceptable. On day 13, Control and P3 were unacceptable.

The sensory scores obtained on day 1 with respect to overall acceptability for control, P1, P2 and P3 were 8.64, 8.33, 8.43 and 8.5, respectively. Similarly the sensory scores obtained on day 4 with respect to overall acceptability for control, P1, P2 and P3 were 8.32, 8.17, 8.21 and 8.39, respectively. The sensory

scores obtained on day 7 with respect to overall acceptability for control, P1, P2 and P3 were 8.1, 7.76, 7.92 and 8.21. On day 10 sensory scores obtained for control and P3 were 7.78 and 7.99 whereas P1 and P2 were unacceptable. On day 13, Control and P3 were unacceptable.

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