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Research Article

Utilization of whey protein concentrate in processed cheese spread

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Abstract

Blends of Cheddar cheese comprising of 66% of 2-3 months old and 34% of 4-5 months old cheddar cheese were used to prepare processed cheese spread. Cheese solids were partially replaced by whey protein concentrate (WPC) (38.00 per cent protein) solids at different levels, viz. 1.5, 3.0 and 4.5 per cent. Incorporation of WPC resulted in a significant improvement in body and texture score of spread particularly at 3.0 and 4.5% level. However, addition of WPC at higher levels imparted a milder flavour to the product. Processed cheese spread with good melt ability, desired characteristics with improved spread ability can be prepared by using dried WPC at levels up to 4.5% of cheese solids.

Keywords: Whey protein concentrate, Cheddar cheese, Cheese spread, Buffalo skim milk, Dairy food product.

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Introduction

There has been a continuous increase in the production of whey protein concentrate (WPC) since the introduction of ultra filtration (UF) process in the food industry. UF is now a major means of WPC production in most of the dairy countries of the world. WPC represent a protein source of excellent nutritional and functional importance. WPC besides being nutritional ingredients in various foods can also be used as a functional ingredient for binding, texturization, colour and aeration properties in a wide variety of food formulations[1-3]. WPCs by virtue of their high protein content and functionality are increasingly used in a great number of food products, for replacing traditional additives like milk powder, egg albumin based foods and is now finding applications in infant and dietetic foods, ice cream and frozen beverages, meat products, pasta and Indian traditional products like *Khoa*[4-8]. WPC also acts as biopreservative due to the presence of antimicrobial proteins.

Awareness of the potential for whey protein as food ingredients has been gaining momentum for more than a decade. Increased production of WPC warrants greater application in the dairy/ food products. The cheese manufacturing industry has considerable interest in utilization of WPC. Processed cheese foods provide a good opportunity for the utilization of non cheese dairy ingredients such as skim milk powder, whey, WPC, etc. There is scanty information available on the manufacture of processed cheese food containing WPC[9-13]. Looking at the potential application of WPC in the processed cheese foods, the present study was undertaken to investigate the suitability of WPC in manufacture of processed cheese spread and evaluate the chemical, sensory and rheological properties of the resultant product.

Materials and Methods

Preparation of WPC

Buffalo skim milk obtained through renneting, setting, cutting, cooking and draining after pasteurization and cooling to 55°C was used to prepare cheddar cheese whey. The whey was then subjected to ultra filtration in an ultra filtration unit (Paterson Candy International Ltd.) to get approximately 15% Total Solids (TS) of the retentate. To this retentate equal amount of water was added and ultra filtration was followed to get diafiltered retentate. The diafiltered retentate was dried using Niro spray dryer at an outlet air temperature of 85-90°C. The resultant WPC had a moisture content of 97.61per cent.

Manufacture of processed cheese spread

For manufacturing of processed cheese spread (PCS), raw Cheddar cheese was procured from Vidya Dairy, Anand Agricultural University, Anand. Good quality young (2-3 months) and 4-5 months old Cheddar cheese blocks were selected on the basis of sensory evaluation by experienced judges, packed in polyethylene bags and stored at about –20°C. Blends comprising of 66% of 2-3 months old and 34% of 4-5 month old Cheddar cheese were prepared. Cheese solids were partially replaced by WPC solids at levels of 1.5, 3.0 and 4.5%. All the blocks of Cheddar cheese were left at room temperature and then shredded. The required amounts of Cheddar Cheese, WPC, salt, trisodium citrate, disodium phosphate and water required per kg product were placed in a stainless steel vessel. The contents of the kettle were indirectly heated with continuous stirring and scraping. Heating was continued till the temperature reached 85-90°C at which it was held for 3-5 minutes. The whole process took about 20 minutes. The hot product was filled immediately in pre-cleaned sterilized plastic cups and stored at 1-2°C.

Analysis

WPC was analyzed for total solids (TS) by gravimetric method with Mojonnier milk tester (Mojonnier Bros Co., Model D, Chicago, US) as per the procedure described in Laboratory manual[14], fat by Gerber method, protein by semi-micro-Kjeldahl's method[15], total ash by standard method[16], titratable acidity as per BIS method[17] and *p*H at 20°C using a *p*H meter (Systronic digital *p*H meter, Model-335). The processed cheese spreads were analysed for moisture by gravimetric method (Mojonnier method) besides the analysis of fat, titratable acidity and *p*H at 20°C. Meltability of cheese was checked by the method described by Olsen and Price (1958)[18]. The consistency of PCS was measured in terms of penetrometer reading using AIMIL make universal cone Penetrometer (Type FPN-3). The reading was taken using a cone and test rod weighing 151.6 and 150.89 g, respectively, for 10 seconds at a product temperature of 7°C.

Sensory evaluation

The processed cheese spreads were subjected to sensory evaluation for flavour, body and texture, colour, appearance and overall acceptability by six experienced judges using the score card recommended by BIS[19].

Statistical analysis

The mean values of each attribute under study obtained from samples of 4 replications were subjected to analysis of variance using the method of Completely Randomized Design with equal number of observations[20].

Results and Discussion

For the manufacture of processed cheese spread, blends of Cheddar cheese comprising of 66% young and 33% old Cheddar cheese were used. Cheese solids were partially replaced by dried WPC solids [total solids, 97.61%; fat, 1.06%; protein, 38.23%; ash, 4.02% and lactose (by difference), 54.30%] at levels of 1.5, 3.0 and 4.5%. Before use, the blocks of Cheddar cheese were left at room temperature, shredded and then processed cheese spread was prepared. The resultant processed cheese spreads made were evaluated for their composition, meltability, consistency and sensory characteristics.

Table 1: Influence of addition of WPC on composition of processed cheese spread

Rate of addition of WPC (%)	Compositional parameters				
	Moisture (%)	Fat (%)	Protein (%)	Acidity (%) (Lactic acid)	*p*H
0	56.77	20.37	15.37	1.33	5.65
1.5	56.11	19.50	15.57	1.43	5.73
3.0	55.37	19.12	16.09	1.46	5.66
4.5	56.28	18.12	17.00	1.45	5.71
CD($P < 0.05$)	NS	0.46	0.25	0.03	NS

CD = Critical difference, NS= Non-significant

Chemical composition, meltability and consistency of processed cheese spread

The chemical composition, acidity and *p*H of processed cheese spreads are shown in Table 1. It is seen that moisture and *p*H of the spreads were not significantly influenced by addition of WPC in the product mix. On the other hand, fat, protein and acidity of the resultant processed cheese spreads differed significantly from the control. Higher values for fat were observed in control and samples supplemented with WPC at 1.5 and 3.5% level. Protein and acidity values were observed higher in samples supplemented with WPC at 1.5, 3.0 and 4.5% levels. All the experimental samples conformed to the PFA and BIS standards prescribed for such products in India.

The results on effect of addition of WPC at different levels on the meltability and firmness of processed cheese spreads are given in Table 2. Incorporation of WPC at 3.0 and 4.5% levels resulted in a significant improvement in the meltability of PCS.

Table 2: Influence of addition of WPC on meltability and consistency of processed cheese spread

Rate of addition of WPC (%)	Meltability (cm)	Penetration value at 10°C (1/10th of mm)
0	3.60	33.12
1.5	3.37	30.25
3.0	4.80	29.91
4.5	5.75	32.47
CD (P<0.05)	0.29	NS

CD = Critical difference, NS= Non-significant

Sensory attributes of processed cheese spread

Table 3 depicts the average sensory scores of processed cheese spread. The average flavour scores of the experimental samples were in the range of 42.25 for 4.5% WPC to 43.75 for controls. Control was adjudged the best. It can be seen from the results that substitution of cheese solids with WPC decreased the flavour score. The preference as per flavour score was in the order control >1.5 >3.0 >4.5%.

Substitution of cheese solids with WPC was found to decrease the flavour scores significantly over control (P≤0.05) at levels above 1.5%. The flavour score of control was at par with 1.5% (P>0.05), whereas 3.0 and 4.5% had significantly (P≤0.05) lower flavour scores than control. The flavour scores of 3.0 and 4.5% were similar (P>0.05). At higher levels the samples were criticized for having mild flavour compared to control and sometimes had flat flavour. Thapa and Gupta[13] and others also reported milder flavour in processed cheese foods containing WPC.

Table 3 : Effect of WPC on the sensory attributes of processed cheese spread

Rate of addition of WPC (%)	Sensory score of processed cheese spread				
	Flavour (50)	Body & Texture (30)	Colour & Appearance (15)	Total score *(100)	Comments
0	43.75	24.04	13.79	88.58	-
1.5	43.33	25.13	13.67	89.13	Slight sticky
3.0	42.71	25.75	13.75	89.21	Good spreadability
4.5	42.25	27.33	13.71	90.29	Good spreadability, mild flavour
CD (P < 0.05)	0.970	1.003	NS	NS	

* Total score out of 100 includes score for package given as 5.0 out of maximum 5.0.
CD = Critical difference, NS = Non-significant

The average scores of body and texture presented in Table 3 indicate superiority of 4.5% over all other samples. These values also indicate that processed cheese spreads containing WPC were preferred with respect to its body and texture characteristics compared to control. Addition of WPC at 4.5% scored the highest marks (27.33) for body and texture followed by 3.0 (25.75); 1.5% (25.13) and control (24.04); 4.5% had significantly superior score over all the rest samples. Higher body and texture score was due to better spreadability of the product and smoothness of the product as confirmed by the panel of judges. Water binding properties of WPC could be one of the reasons for improvement in firmness and spreadability of the product.

The colour and appearance scores of all the products were found to be statistically non-significant ($P>0.05$). The total scores of all the products were found to be statistically non-significant ($P>0.05$). This was because there was a decrease in flavour scores in experimental samples and an increase in body and texture scores which nullified the effect on total scores.

Conclusion

It can be concluded that processed cheese spread with good meltability, desired body and texture characteristics, and improved spreadability can be prepared by using dried WPC at the rate of 4.5% of cheese solids.

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