RESEARCH ARTICLE

Storage induced changes in sensory characteristics and viscosity of cocoa and whey protein enriched functional dairy drink

HR Gupta, SK Kanawjia, MK Saluja and Prateek Sharma

Received : 09 February 2017 / Accepted: 15 March 2017

Abstract: The functional dairy drink product developed in the present study was packaged in LDPE pouches stored at refrigeration temperature 4±1° C. The results of storage studies depict that the product can be stored upto 18 days at 4±1° C without significantly affecting its sensory qualities. Overall acceptability scores decreased from initial 93.0 to 69.2 after 18 days of storage at 4±1° C for the drink enriched with whey protein; for the drink enriched with whey protein and cocoa, the scores decreased from 93.4 to 72.4. The consistency score of the product decreased from 27.5 to 19.5 for whey protein enhanced drink and from 27.7 to 20.6 in case of cocoa & whey protein enriched product after 18 days of storage at 4±1°C in LDPE pouch. The Color and appearance score decreased from 18.6 to 14.1 for the whey protein enriched drink and to 15.3 for the product enriched with cocoa & whey protein. The study clearly depicted that the sensory attributes viz. overall acceptability, flavor, taste, consistency and color &appearance scores between 15th and 18th day of storage of both the products differed significantly; indicating that the products were shelf stable upto 15th day when stored at 4±1° C.

Key words: Functional dairy drink, sensory characteristics, cocoa and WPC

Introduction

Health and nutrition are very relevant topics in current context across the globe (Bhat and Bhat, 2011). Milk provides an adequate amount of protein in an otherwise protein deficient Indian diet. Milk proteins are an excellent source of essential amino acids, and they do not contain any anti-nutritional factors (Pouliot and Gauthier, 2006). High protein milk is beneficial for enhancing the physical fitness, decreasing obesity while maintaining muscle and bone strength of the consumers. Milk proteins have biological activities ranging from antimicrobial ones to those facilitating absorption of nutrients, as well as acting as growth factors, hormones, enzymes, antibodies and immune stimulants. Milk proteins provide flavour, mouth-feel, viscosity and structure to dairy foods. Increased sale of low fat milk and skim milk shows the change in pattern of fluid milk consumption due to nutrition and health concerns of consumers. High protein milk provides the dietary requirement of protein for lactating and pregnant women, sports persons, growing children and muscle development and maintenance in adults (Korhonen and Pihlanto, 2006). Milk beverage is one of the important dairy products which is very popular amongst the people of all ages (Jayaprakasha and Brueckener, 1999).

Looking at the need for healthy nutrition, a WPC and cocoa enriched dairy drink was developed. The current work focused upon studying changes occurring in sensory and organoleptic properties during storage of the functional dairy drink.

Materials and Methods

Raw materials

Buffalo milk for the preparation of functional dairy beverage was procured from Experimental Dairy of National Dairy Research Institute, Karnal and adjusted to 1.5, 3.0 and 4.5% fat level using skim milk. The milk samples were pasteurized and kept under refrigerated condition. The WPC 70 procured from Modern Dairies Limited, Karnal was used for optimizing functional dairy drink. The composition of WPC 70 was moisture 5.5%, protein 77.0%, fat 8.0%, lactose 6.5% and minerals 3.0%. The LDPE film (thickness 70 µm) was used for the packaging of formulated dairy drink. Carrageenan was procured from Sigma Aldrich Co., predominately containing k-Carrageenan. Cane Sugar was purchased from local market and ground to powder form before mixing with standardized milk.

Preparation of functional dairy drink:

HR Gupta[1](✉), SK Kanawjia[1], MK Saluja[2], Prateek Sharma[1]
[1]Dairy Technology Division,
ICAR-National Dairy Research Institute, Karnal-132001, India
[2] School of Agriculture, IGNOU, Delhi

HR Gupta[1]
Dairy Technology Division
ICAR-National Dairy Research Institute, Karnal-132001, India
Email: hrgndri@gmail.com

The dairy drink was prepared as per the flow diagram given below (Fig. 1)

The independent variables used in this investigation were: WPC (0.5-5.0%), Sugar (6-8%), Carrageenan (0.2-1.0%) and Milk fat (1.5-4.5%). The responses selected were flavour, taste, consistency, colour and appearance and overall acceptability. The experiment comprised of 30 trials. The samples of various formulations were served to the panel of 8 sensory judges. The results of the sensory judgment were subjected to statistical analysis in the quadratic model. Regression analysis and analysis of variance (ANOVA) was conducted for fitting the models and to examine the statistical significance of the model. The adequacy of the models was determined using lack-of fit and R^2 (coefficient of determination) as outlined by Lee *et al* (2003).

Sensory analysis

A 100 point score card suggested by American Dairy Science Association (1941) was used for the sensory evaluation. Sensory evaluation of milk was done by 8 judges of the trained sensory panel. Functional drink samples were served to judges after tempering them to 15-20ÚC.

Results and Discussion

During storage, many changes takes place in the product properties, which include chemical, bio-chemical and physical changes. Changes in these properties alter sensory attributes of the product. After certain period of storage, the product becomes unacceptable due to excessive changes resulting in certain sensory defects. Rate of deterioration in the product depends upon various factors among which storage conditions and packaging material are important.

The product developed in the present study was packaged in polyethylene pouches and stored at 4±1°C. Sample was drawn at an interval of three days for various physico-chemical analysis and sensory evaluation to judge the changes taking place in the product with time.

Overall acceptability score

Average overall acceptability scores were found higher (Table 2) in cocoa & whey protein enriched functional dairy drink (88.61) as compared with whey protein enriched functional dairy drink (87.05). Decrease in overall acceptability scores was observed from initial value of 93.00 to 69.20 after 18 days of storage for the drink enriched with whey protein. For the drink enriched with cocoa & whey protein, the scores decreased from 93.40 to 72.40 (Table 1). Both the storage period and treatments significantly affected the overall acceptability scores of the product.

Table 2 clearly depicts that the overall acceptability score between 15th (85.46 & 88.60) and 18th (69.16 & 72.43) day of storage of both the products differed significantly; indicating products are stable up to 15th day when stored at 4±1º C.

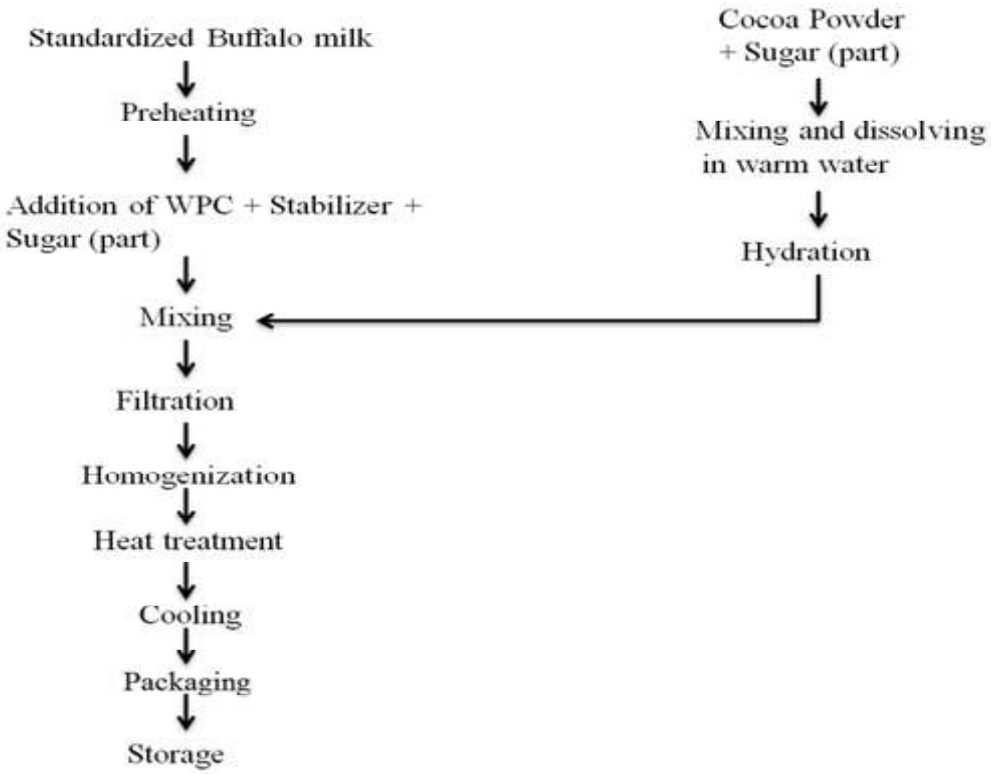

Fig. 1. Flow diagram for the preparation of cocoa flavoured whey protein enriched functional dairy drink

Table 1: Changes in sensory attributes of whey protein and cocoa & whey protein enriched functional dairy drink packaged in LDPE pouch and stored at 4±1°C

Storage Days	Sensory Attributes									
	Overall Acceptability (100)		Flavor (25)		Taste -(25)		Consistency (30)		Colour & Appearance (20)	
	WPC	Cocoa +WPC	WPC	Cocoa +WPC	WPC	Cocoa +WPC	WPC	Cocoa +WPC	WPC	Cocoa +WPC
0	93.0±1.68	93.4±1.08	23.2±0.68	23.5±0.56	23.7±0.85	23.3±0.52	27.5±0.63	27.7±0.65	18.6±0.56	18.6±0.41
3	91.8±1.45	92.9±1.57	22.8±1.00	23.2±0.61	23.6±0.45	23.2±0.46	27.2±0.58	27.1±0.58	18.0±0.45	18.3±0.47
6	91.0±1.96	91.8±1.78	22.5±0.75	23.2±0.42	22.9±0.58	22.7±0.76	26.7±.75	26.7±0.75	17.7±0.35	18.1±0.52
9	90.2±0.98	91.1±1.96	22.2±0.52	22.8±0.63	22.2±0.42	22.5±0.86	26.1±0.56	26.1±0.56	17.5±0.38	17.9±0.35
12	88.8±1.02	90.1±1.25	22.0±0.45	22.6±0.25	22.0±0.46	22.0±0.43	25.6±0.85	25.5±0.65	17.3±0.48	17.7±0.36
15	85.5±1.45	88.6±1.32	21.2±0.68	20.4±0.61	20.7±0.28	21.7±0.56	24.7±0.74	25.1±0.42	17.0±0.56	17.4±0.29
18	69.2±0.96	72.4±1.12	18.0±0.98	18.6±0.85	16.6±0.46	16.9±0.76	19.5±0.65	20.6±0.56	14.1±0.49	15.3±0.38

Flavor score

Average flavour score was found higher but non significant in cocoa & whey protein enriched functional dairy drink (20.04) than whey protein enriched functional dairy drink (21.72). The flavour score of the product decreased from 23.2 to 18.0 in case of whey protein enriched drink and from 23.5 to 18.6 in case of cocoa & whey protein enriched drink after 18 days of storage at 4±1°C (Table 1). The decrease in flavor score was particularly perceivable after 12 days of storage in both the variants (Fig 2B). Significant difference was found with increase in time period and with the treatment, indicating that addition of cocoa resulted in higher flavor score (Table 3). Table 3 clearly depicts that the CD of flavor score between 15th (21.26 & 20.40) and 18th (18.06 & 18.60) day of storage of both the products differs significantly indicating flavor of the products were found to be acceptable only upto 15th day when the product is stored at 4±1° C. The results are in agreement with the research finding of Bihari (2012).

Taste score

The taste scores of the product decreased from 23.7 to 16.6 in case of whey protein enriched drink and from 23.3 to 16.9 in case of cocoa & whey protein enriched drink after 18days of storage at 4±1°C (Table 1 & Fig 2A). Significant difference ($P<0.05$) was found with increase in time period, indicating that addition of cocoa resulted in higher flavor score to the product as compared to WPC alone. Interaction effect of storage period and treatment was found to be non significant on sensory score of the product (Table 7). It is observed from the Table 4 that the CD of taste score between 15th (20.73 & 21.70) and 18th (16.63 & 16.96) day of storage of both the products found to differ significantly indicating taste of the products was found to be acceptable up to 15th day when it was stored at 4±1° C.

Consistency score

It is observed from the Table 7 that a highly significant ($p<0.01$) decrease in consistency score of the product occurred during storage period (Table 7). The Consistency score of the product decreased from 27.5 to 19.5 for whey protein enhanced drink and from 27.7 to 20.6 in case of cocoa & whey protein enriched product after 18 days of storage at 4±1°C in LDPE pouches. Addition of cocoa did not show significant effect on consistency score of the product during storage (Fig 3B). From the Table 5 it is observed from the CD values that the consistency score between 15th (24.70 & 25.13) and 18th (19.53 & 20.66) day of storage of both the products were found to differ significantly, indicating consistency of the products were found to be good up to 15th day when it is stored at 4±1° C.

Colour & appearance score

Average color & appearance score was found significantly higher in cocoa & whey protein enriched functional dairy drink (17.6714)

Table 2: Average overall acceptability scores of whey protein and cocoa & whey protein enriched functional dairy drink during storage at 4±1ºC

Treatment	Days							Overall Mean
	0	3	6	9	12	15	18	
WPC	92.9667	91.7667	91.0333	90.2333	88.7667	85.4667	69.1667	87.0571
Cocoa+ WPC	93.3667	92.8667	91.8333	91.1333	90.0667	88.6000	72.4333	88.6143
Overall Mean	93.1667	92.3167	91.4333	90.6833	89.4167	87.0333	70.8000	

C.D. (Treatment) = 0.7017
C.D. (Days) =1.3126
C.D. (Treatment x days) =NS

Table 3: Average flavour scores of whey protein and cocoa & whey protein enriched functional dairy drink during storage at 4±1ºC.

Treatment	Days							Overall Mean
	0	3	6	9	12	15	18	
WPC	23.1000	22.8667	22.5000	22.2667	22.0000	21.2667	18.0667	21.7238
Cocoa + WPC	23.5000	23.2333	23.1667	22.8000	22.6000	20.4000	18.6000	22.0429
Overall Mean	23.3000	23.0833	22.8333	22.5333	22.3000	20.8333	18.3333	

C.D. (Treatment) =NS
C.D. (Days) =1.0874
C.D. (Treatment x days) =NS

Table 4: Average taste scores of whey protein and cocoa & whey protein enriched functional dairy drink during storage at 4±1ºC

Treatment	Days							Overall Mean
	0	3	6	9	12	15	18	
WPC	23.70	23.17	22.90	22.20	22.00	20.73	16.63	21.62
Cocoa + WPC	23.37	23.20	22.77	22.50	22.07	21.70	16.97	21.80
Overall Mean	23.53	23.18	22.83	22.35	22.03	21.22	16.80	

C.D. (Treatment) =NS
C.D. (Days) =0.8297
C.D. (Treatment x days) =NS

Table 5: Average consistency scores of whey protein and cocoa & whey protein enriched functional dairy drink during storage at 4±1ºC

Treatment	Days							Overall Mean
	0	3	6	9	12	15	18	
WPC	27.5000	27.2000	26.7667	26.1667	25.6000	24.7000	19.5333	25.3524
Cocoa+ WPC	27.7333	27.1000	26.7000	26.1000	25.5000	25.1333	20.6667	25.5619
Overall Mean	27.6167	27.1500	26.7333	26.1333	25.5500	24.9167	20.1000	

C.D. (Treatment): NS
C.D. (Days): 1.2688
C.D. (Treatment x days): NS

than whey protein enriched functional dairy drink (17.2048) (Table 6). Colour and appearance score decreased from 18.6 to 14.1 for the whey protein enriched drink and to 15.3 for the product enriched with cocoa & whey protein (Table 6, Fig 3 C). Period of storage and addition of cocoa was found to have significant effect ($p< 0.05$) on the color & appearance score of the product, however interaction between treatment and storage period was found to be non- significant (Table 7). Bihari (2012) also recorded similar results of decrease in the score of color & appearance during storage of milk with enhanced protein content.

Viscosity

Viscosity of the product was found to increase non-significantly during storage of 18 days in WPC enriched functional drink and in case of cocoa & whey protein enriched functional drink it was found to decrease non significantly ($p>0.05$) (Table 9). . Viscosity of the product increased from 1.61 to 2.62 cP at the end of storage of 18 days in case of WPC enriched product and decreased from 2.37 to 1.38 cP in case of cocoa & whey protein enriched product (Table 8 and Fig 4). The present results are in agreement with Quinones, *et al.,* (1997) and Bihari (2012). Both recorded that

Table 6: Average color & appearance scores of whey protein enriched and cocoa & whey protein enriched functional dairy drink during storage at 4±1ºC

Treatment	Days							Overall Mean
	0	3	6	9	12	15	18	
WPC	18.6333	18.0333	17.7000	17.5000	17.3667	17.0333	14.1667	17.2048
Cocoa+ WPC	18.6333	18.3667	18.1667	17.9667	17.7333	17.4667	15.3667	17.6714
Overall Mean	18.6333	18.2000	17.9333	17.7333	17.5500	17.2500	14.7667	

C.D. (Treatment) = 0.4583
C.D. (Days) = 0.8573
C.D. (Treatment x days) =NS

Table 7: ANOVA of changes in sensory attributes of whey protein enriched functional dairy drink packed in LDPE pouch and stored at 4±1°C

Source	Variable	Sum of squares	Df	Mean sum of square	F-value
Treatment	Overall Acceptability	25.4593	1	25.4593	20.66**
	Flavor	136.4402	1	136.4402	1.18*
	Taste	0.3259	1	0.3259	0.66*
	Consistency	0.4609	1	0.4609	0.40
	Colour & Appearance	2.2867	1	2.2867	4.35*
Days	Overall Acceptability	2177.4514	6	362.9085	294.48**
	Flavor	952.5728	6	158.7621	1.37
	Taste	189.7362	6	31.6227	64.22**
	Consistency	231.6895	6	38.6149	33.54**
	Colour & Appearance	57.1557	6	9.5259	18.12**
TreatmentxDays	Overall Acceptability	12.0390	6	2.0065	1.63*
	Flavor	685.9881	6	114.3313	0.99
	Taste	1.5790	6	0.2632	0.53
	Consistency	1.8724	6	0.3121	0.27
	Colour & Appearance	1.1767	6	0.1961	0.37

Table 8: Average viscosity (cP) values of whey protein and cocoa & whey protein enriched functional dairy drink during storage at 4±1ºC

Treatment	Days							Overall Mean
	0	3	6	9	12	15	18	
WPC	1.61	1.73	1.88	2.06	2.24	2.44	2.64	2.09
Cocoa+ WPC	2.37	2.24	2.08	1.95	1.78	1.58	1.38	1.91
Overall Mean	1.990	1.99	1.98	2.01	2.01	2.01	2.02	

C.D. (Treatment)= NS
C.D. (Days)= NS
C.D. (Treatment x days)=0.6993

Table 9: ANOVA of changes in viscosity (cP) of whey protein and cocoa enriched functional dairy drinks packed in LDPE pouch and stored at 4±1°C

Source of variation	Type III sum of squares	df	Mean Square	F-value
Treatment	0.31	1	0.31	1.78
Days	0.01	6	0.006	0.01*
Treatment x Days	4.81	6	0.80	4.58

increase in protein to milk increased its viscosity during storage. In case of cocoa enriched product the viscosity was found to be decreased from 2.37 to 1.38 cP at the end of storage of 18 days (Table 9). The decrease in prolonged storage of the cocoa enriched drink may be attributed due to the weak network formed by cocoa particle and when shear during transfer of the sample is applied to the cocoa enriched functional dairy drink the network is broken and recorded low viscosity. The similar results were recorded by Hanne, (2010).

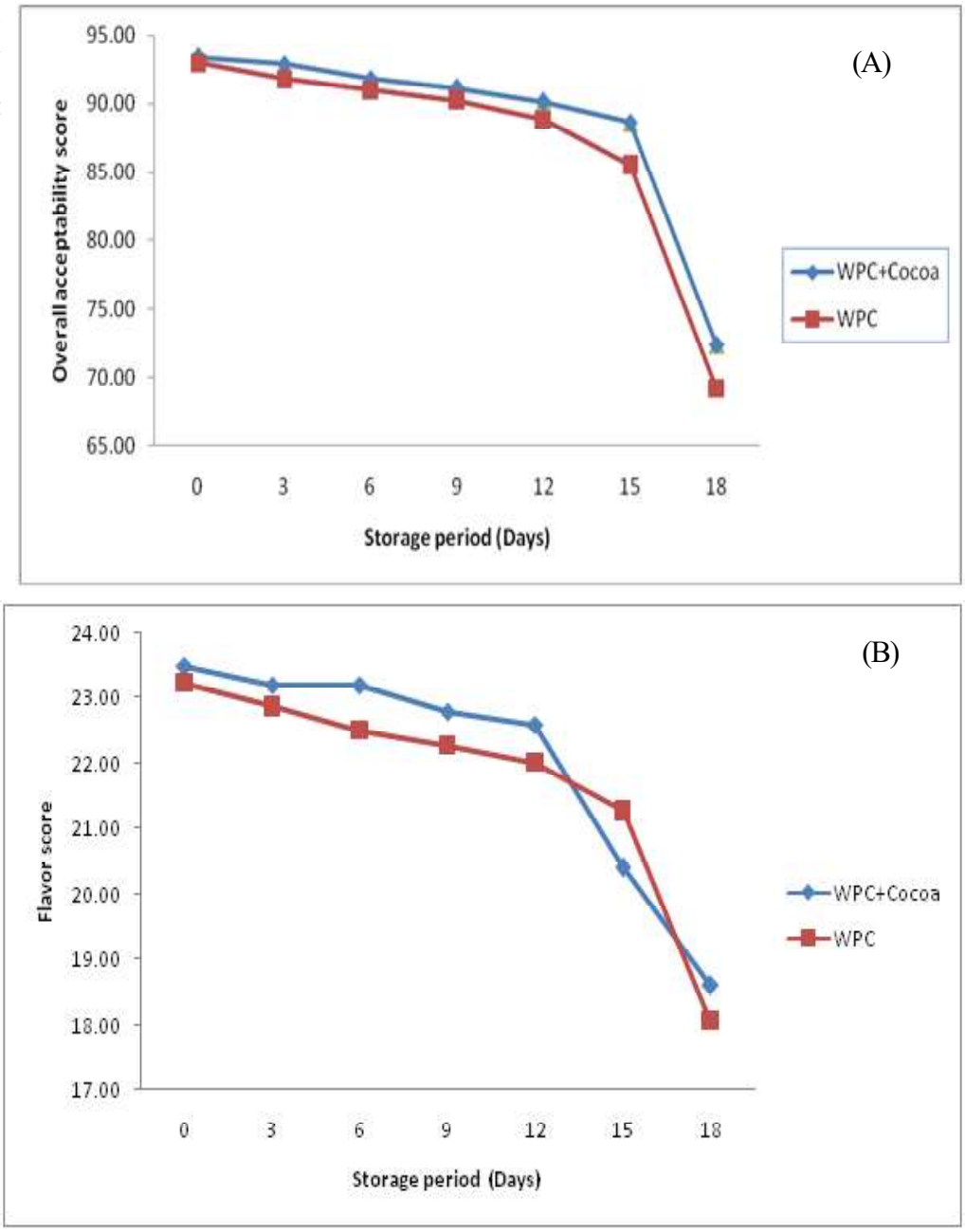

Fig. 2: Changes in overall acceptability and of whey protein and cocoa & whey protein enriched functional dairy drink during storage at 4±1°C. (A & B)

Table 10: Rank correlation coefficient between different sensory parameters in whey protein enriched functional dairy drink

	Flavour	Taste	Consistency	Color & Appearance
Overall acceptability	0.9649**	0.9594**	0.9669**	0.8882**
Flavour		0.9509**	0.9753**	0.8711**
Taste			0.9503**	0.9037**
Consistency				0.8940**

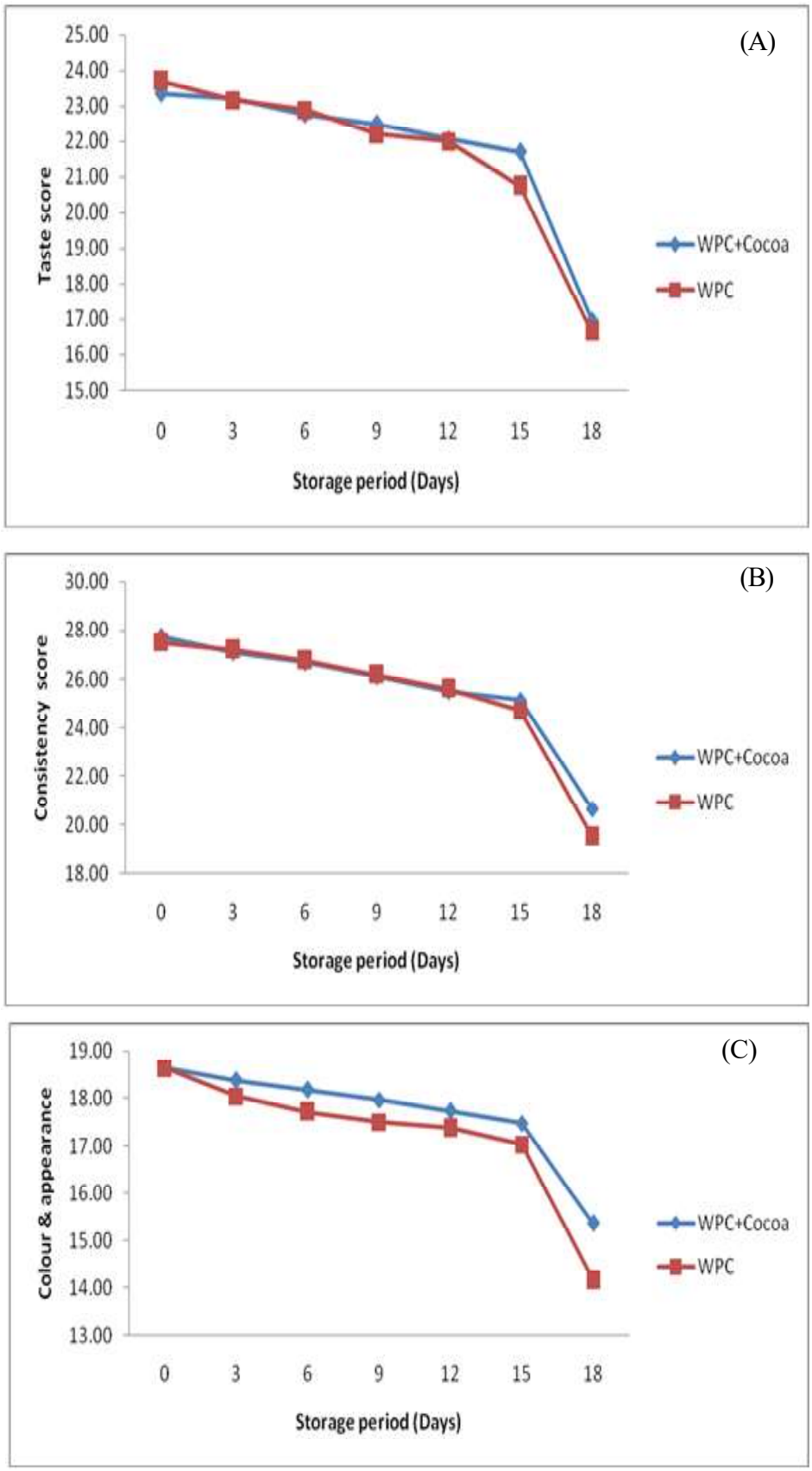

Fig. 3: Changes in taste, consistency and color & appearance of whey protein and cocoa & whey protein enriched functional dairy drink during storage at 4±1°C. (A, B & C)

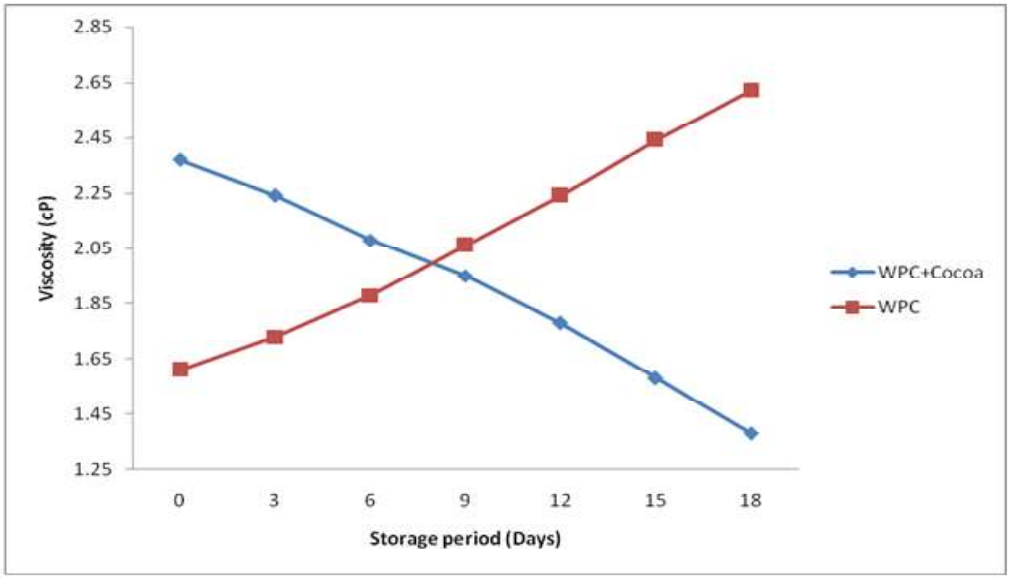

Fig. 4. : Changes in viscosity of whey protein and cocoa & whey protein enriched functional dairy drink during storage at 4±1°C.

Table 11: Rank correlation coefficient between different sensory parameters in cocoa & whey protein enriched functional dairy drink

	Flavour	Taste	Consistency	Color & Appearance
Overall acceptability	0.8999**	0.9603**	0.9652**	0.9299**
Flavour		0.8847**	0.8744**	0.8320**
Taste			0.9295**	0.9257**
Consistency				0.9310**

Rank correlation between sensory parameters of whey protein and cocoa & whey protein enriched functional dairy drink

Rank correlation coefficient can be used to assess the significance of the relation between two rankings. Table 10 and 11 depicts the rank correlation coefficient between the sensory parameters of whey protein enriched and cocoa & whey protein enriched functional dairy drink respectively. It is clear from both the tables that all the sensory parameters viz. flavor, taste, consistency and color & appearance was found to have direct and significant ($p<0.01$) correlation with overall acceptability. Consistency of the product influenced the overall acceptability and flavor score significantly compared to other sensory parameters. The consistency and flavour of the product showed close and highly significant ($p<0.01$) correlation among all the sensory parameters indicating the more the consistency of the functional drink, the greater will be the flavor score perceived by the judges. Similar results were noticed for the product enriched with cocoa and whey protein enriched functional drink.

Conclusions

Sensory evaluation gives a fair idea of product quality as it reflects the sum total of all the changes that have taken place in the product during storage. The product developed in the present study was packaged in Low Density Polyethylene (LDPE) and stored at refrigeration temperature 4±1° C. The product was evaluated for sensory attributes and viscosity during storage. Decrease in the all sensory scores of the drink enriched with whey proteins was observed after storage for 18 days. Significant difference in sensory characteristics was found with increase in time period and with the treatment, indicating that addition of cocoa resulted in higher flavor score to the product as compared to whey protein alone.

References

Bhat, ZF and Bhat, H (2011) Milk and dairy products as functional foods – a review. Int. J. Dairy Sci., 6: 1-12.

Bihari, H (2012) Production of milk with enhanced protein content. M.Sc. Thesis submitted to the National Dairy Research Institute, Karnal

Hanne K Ludvigsen, (2010) How to make a delicious chocolate milk. Palsgard Technical paper; 10:1-5.

Jayaprakasha, HM and Brueckener, H (1999) Whey protein concentrates: a potential functional functional food ingredient for food Industry. J. Food Sci. Technology, 36 (3): 189-204

Korhonen, H and Pihlanto, A (2006). Bioactive peptides: production and functionality Int Dairy J 16: 945–960

Lee, KW, Kim, YJ, Lee, HJ, and Lee, CY (2003) Cocoa has more phenolic phyto chemicals and a higher antioxidant capacity than teas and red wine. J. Agri. Food Chem., 51: 7292–7295.

Pouliot Y and Gauthier S (2006) Milk growth factors as health products: Some technological aspects Int Dairy J 16:1415–1420

Quinones, HJ, Barbano, DM and Phillips, LG (1997) Influence of protein standardization by ultrafiltration on the viscosity, colour, and sensory properties of skim and 1% milk. J Dairy Sci, 80: 3142–3151