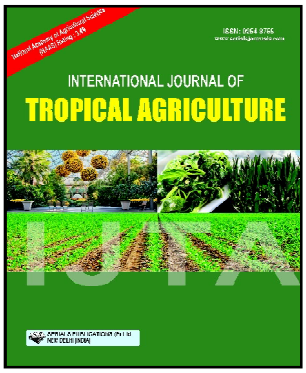

INTERNATIONAL JOURNAL OF TROPICAL AGRICULTURE

ISSN : 0254-8755

available at http: www.serialsjournals.com

Volume 36 • Number 2 • 2018

Storage studies on Physico -chemical and Sensory Caracteristics of Inulin Enriched, Sterilized Fortified Flavoured Milk Drink

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Abstract: There is growing concern about "Health" among consumers, and they look forward for products that carry "Healthy Image". Though flavoured milk is a rich source of protein, minerals, and its high fat contents limits its consumption. The fat can be replaced using soluble fibers "Inulin". Therefore, an investigation has been done to exploit the technological benefits of inulin by replacing milk fat @ 0, 1, 2 and 3%; with vitamin A and iron fortification for development of sterilized flavoured milk drink. The fresh and stored sterilized products were subjected to physical, chemical, microbial and sensory analysis. After accelerated storage, control T_0 had the lowest per cent of 18.47, 3.64, 0.67 and 11.11 for total solids, protein, ash and carbohydrate, while T_3 had the highest value of 18.67, 3.98, 0.70 and 13.88 respectively after storage. In sensory analysis, the T_2 secured the highest scores on colour and appearance (7.68), flavour (7.8), mouthfeel (7.9), sweetness (7.52) and overall acceptability (8.01) even after storage.. Therefore, it can be concluded that replacement of milk fat by 2 % inulin (T_2), could be used to develop a fortified milk drink with better physical, chemical and sensory parameters even after storage with reduced cost as compare to control.

Keywords: flavoured milk, fortification, inulin, sterilization.

INTRODUCTION

India is the largest milk producer in the world and the production in 2016- 17 is about 169.4 Million Tones. (*http://www.nddb.org*). Milk comes in many varieties and its health benefits are well-re-searched and documented. It is a key source of

macronutrients, calcium, magnesium, phosphorus, vitamin D, vitamin A, riboflavin, vitamin B-12, and potassium for children and teenagers (Fiorito *et al.*, 2006 and Moore *et al.*, 2005. With the advent of urbanization and changes in socio-economic set up, fast foods are gaining ground. Generally, only fast foods are considered as junk foods which supply very less nutritious. Though milk is considered as perfect food which not only takes very less time to consume but also full of nutrition.

As milk in its natural form is not considered suitable for many people, for example, those suffering from heart ailments and infant and sick persons also cannot properly digest full fat milk. Flavoured milk is also a delicious drink that comes in this category but the disadvantage is its high fat and sugar contents which give high calories. All these problems can be counteracted by manufacturing low fat flavoured milk. Though flavourd milk is a rich source of protein, minerals, its fat contents limits its consumption (i.e. high in saturated fat) especially people who suffer from heart diseases and diabetics. This can be overcome by replacing milk fat with soluble fibres. Meijers (2010) reported that several clinical investigations have proved that all fibers either soluble or insoluble are equally important for health. In the functional food market, as ongoing research finds "Inulin" has several health benefits viz., reduces risk of chronic diseases, diabetes and intestinal cancer.

Inulin also has unique technological properties such as fat, sugar replacer, texture agent etc (Tako *et al.*, 2007). It attracts water and form a gel, which slows down digestion. It delays the emptying of our stomach and makes feel full, subsequently helps control weight. Lower stomach emptying may also affect blood sugar levels and have a beneficial effect on insulin sensitivity, which may help control diabetes (Kelly, 2009). Inulin is not broken down by the weak acid in the saliva and the bacteria in the mouth and does not cause dental carries or cavities. It promotes an increase in the mass and health of intestinal *Lactobacillus* and *Bifidobacterium* populations (Kolida *et al.,* 2002). Kaur and Gupta (2002) reported that dietary inulin has also been shown to increase calcium, magnesium and iron absorption, contribute to bone mineralization in young adolescents which reduces bone loss and improves bone density. The benefits of inulin on human health coupled with interesting technological properties have focused the research in this ingredient, to be used for incorporation in many dairy and food products (Roberfroid, 2007) like ice cream (Wood, 2011), yogurt, (Guven *et al.*, 2005) etc.

Due to the replacement of milk fat by inulin, the fat-soluble vitamin, such as vitamins A is lost but it can be compensated through fortification. Milk or other dairy products are close to ideal food that contains all nutrients required for newborn, adults and older ones; however, it is generally poor source of iron (0.2 to 0.52 mg/l) as against calcium (1277.3 mg/l) and phosphorus (963.28 mg/l). Iron deficiency is the most common micronutrient deficiency in the world affecting 1.3 billion people i.e. 24% of the world population (El Behairy *et al.,* 2011). Iron enriched diet is the best way to address above problem.

Therefore, an investigation has been carried out to exploit the benefits of inulin, with fortification of milk by selected micronutrients i.e. iron and vitamin A for development of flavoured milk drink with improved nutritional and functional properties which is acceptable for all age groups with fulfillment of healthy product.

MATERIALS AND METHOD

Raw Materials

The fresh cow milk was collected from a private dairy farm in Raipur. The cane sugar was also procured from local market of Raipur. A food grade inulin powder with a company of Cosucra group Warcoing,

Belgium is procured from Vilco Ingredients Pvt. Ltd. Mumbai. Iron (II) sulfate heptahydrate cryst. Purified (Ferrous Sulfate) for fortification of product (Merck Pvt. Ltd.) and vitamin A Acetate from Loba Chemicals Pvt. Ltd will be used for food fortification. Cremadon Sampurna from Danisco co. was used as stabilizing agent in the manufacturing of flavoured milk drink.

Preparation of Inulin enriched Fortified Flavoured milk drink

For the preparation of inulin enriched sterilized fortified flavoured milk drink, several preliminary trials have already been conducted. The product was prepared as per procedure given by Bhardwaj and Beniwal (2009) with some modifications to optimize the level of inulin content and presented in fig 1. The product was also fortified with iron and vitamin A based on review and daily recommended intake level, ferrus sulfate and vitamin A were selected for fortification at a level of 0.001% and 0.012% respectively, while sugar and stabilizer were kept constant i.e. 7 % and 0.05% respectively.

In the manufacturing of IESFFMD, milk fat was replaced with inulin @ 0, 1, 2 and 3% levels constituting treatment details viz. T_0 (3 % milk fat + 0% inulin), T_1 (2% milk fat + 1% inulin), T_2 (1% milk fat + 2% inulin) and T_3 (0% milk fat + 3% inulin).

Analysis

For each treatment, the samples were analyzed for pH by using "Elico pH analyser" after standardization of buffer solution of different pH at 20° C and the colour by using Hunter Lab Colour Scale. The specific gravity was determined by finding out the weights of a certain volume of milk and of the same volume of distilled water at the same temperature taken in a pyknometer. The viscosity of the inulin enriched flavoured milk drink was also determined by Ostwald viscometer (Singh *et al.*, 2006). The fat content, titrable acidity and Total Solid

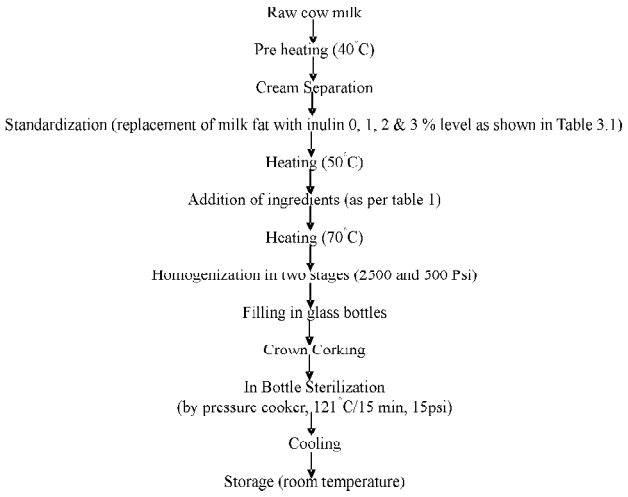

Figure 1: Preparation of inulin enriched sterilized fortified flavoured milk drink

(TS) of milk was estimated by BIS 1479, Part I, 1981. The Ash content was determined by using Muffle Furnace using AOAC (2000) method. The protein content of the product was estimated as per the procedure SP: 18, Part XI (BIS, 1981) using the Pelican Kel plus nitrogen estimation system. The total carbohydrates were calculated by the "By – difference" method. The spore former count for representative samples of inulin enriched flavoured milk drink was determined as per the standard procedure (Bridson, 1995). The sensory evaluation of fresh products were carried out for colour and appearance, flavour, mouthfeel, sweetness and overall acceptability by using standard score card on a 9-point hedonic scale with a panel of five expert judges as suggested by Amerine, (1965).

Data obtained during the course of investigation were subjected to statistical analysis. The effect of different levels of inulin concentration on physical and chemical parameter of the product was evaluated using Completely Randomized Design and Sensory data were analyzed by Split-plot time experiment in Randomized Block Design with 4 treatments as main effects, 5 judges (block effects), 2 storage days as subplot effect and 5 replications (trials) for sensory parameters Statistical analysis of

data will be carried out as prescribed by Steel and Torrie (1981). The shelf life of the product was studied by subjecting the flavoured milk drink to accelerated storage. The product was placed in an incubator at 55°C for 5 days storage. After accelerated storage the products were also evaluated with the parameters same as fresh products.

RESULTS AND DISCUSSION

Fresh cow milk was used to prepared the inulin enriched sterilized fortified flavoured milk drink and the composition is presented in the Table 1.

Table 1
Chemical composition of cow milk

S. No.	*Components*	*Value (per cent)*
1.	Fat	4.3
2.	SNF	8.78
3.	Total Solids	12.68
4.	Acidity (in terms of LA)	0.14
5.	pH	6.6
6.	Protein	3.45
7.	Ash	0.66

All values are average of five replications

Effect of inulin incorporation on the physical characteristics of fresh as well as stored inulin enriched sterilized fortified flavoured milk drink (IESFFMD)

The IESFFMD was analyzed for physical characteristics like pH, specific gravity, viscosity and colour etc. and the results are presented in Table 2.

The data showed a mixed trend on the pH values among control and IESFFMD samples which was well reflected by non-significant difference in the observed parameter. There is a gradual and significant increase in the specific gravity values among flavoured milk samples. The increase in specific gravity at all level of inulin incorporation as compared to control could be due to the fact that basically inulin itself had specific gravity of 1.35 (Silva, 1996). Furthermore, removal of fat (0.93) subsequently increased the serum portion that might have also contributed to the above said effect The result of the present findings on specific gravity is in agreement with Mittal and Bajwa (2012) reported an increase in specific gravity when fat was replaced with sugar substitutes in developing low calorie milk

Table 2
Effect of inulin incorporation on physical characteristics of fresh as well as stored inulin enriched sterilized fortified flavoured milk drink

Treatment	*pH*			*Sp. Gravity*			*Viscosity*		
	Fresh	*Stored*	*Treatmean*	*Fresh*	*Stored*	*Treatmean*	*Fresh*	*Stored*	*Treatmean*
T0	6.46	6.34	6.40^{A}	1.022	1.022	1.022^{A}	4.63	4.55	4.59^{A}
T1	6.40	6.31	6.35^{A}	1.029	1.030	1.029^{B}	5.24	5.05	5.14^{B}
T2	6.52	6.40	6.46^{B}	1.035	1.036	1.036^{C}	5.55	5.56	5.55^{C}
T3	6.38	6.29	6.34^{A}	1.042	1.043	1.043^{D}	5.74	5.73	5.73^{C}
Storage Mean	6.44	6.33	-	1.030	1.033	-	5.22	5.29	-
S Em	0.029 (TxS)	0.015 (S)	0.025 (T)	0.0006 (TxS)	0.0003 (S)	0.0010 (T)	0.0598 (TxS)	0.0299 (S)	0.0646 (T)
CD	NS (TxS)	0.044** (S)	0.076* (T)	NS (TxS)	NS (S)	0.0030 (T)	NS (TxS)	NS (S)	0.199** (T)

** Significant at 1 per cent level

The superscript A, B, C,…… are indicate the comparison of variables with respect to inulin incorporation levels based on the LSD values

drink. The viscosity also significantly increased in the IESFFMD as the level of inulin incorporation increased. This might be attributed by the interaction effect of the dietary fibre (inulin) with the water phase of the milk. The present finding is in alignment with Villages *et al.* (2007), reported that viscosity of 3.1% fat whole milk could be approximated by skim milk with inulin content. In another study of low fat ice cream with 4 % inulin addition, Akalin and Erisir (2008) observed that inulin addition changed the rheological properties, resulting in significantly higher viscosities, consistency and hardness in ice-cream samples.

The value of L* significantly decreased as inulin addition or fat replacement increased in the product, indirectly reflecting that the product is gradually getting darker as compared to control. This might be due to the participation of inulin (fruco oligosaccharide) along with cane sugar and lactose in Maillard's browning. Singh *et al.,* (1992) reported that Maillard's reactions, which start with binding of aldehyde group of sugars with amino groups of proteins and these reactions consist of a series of changes whose consequence is the formation of brown-coloured pigments, such as pyralysins and melanoidins, polymers such as lactulose-lysine or fructose-lysine, as well as low-molecular weight acids.The a* and b* values significantly increased as the fat replacement with inulin incorporation increased.

The IESFFMD samples were subjected to accelerated storage studies (55°±2°C for 5 days). In storage condition there was a decrease in pH which was significant when the product was subjected to accelerated storage at 55°C for 5 days as compare to fresh. The decrease in pH during storage of milk could be attributed to increase in the concentration of free fatty acids, lactic acid and other organic acids and that resulted from degradation of milk components mainly lactose and also inulin. Changes in calcium phosphate equilibrium might also be responsible for reduced pH of stored UHT milk (Rahman and Salariya, 2005). The results was in line with Mohammedali *et al.* (2013) who recorded the decrease in pH during storage of traditional thari kanchi payasam in flexible retort pouches at the temperature of 55°C. The interaction between treatment and storage was found to be non significant. During storage there was a slight decrease in specific gravity of stored IESFFMD which ranged from 1.03 to 1.033 and showed non significant effect. The treatment and storage interaction was also found to be non significant. The viscosity was incresed with incresed addition of inulin and this could be due to the hygroscopic nature of inulin. The effect of inulin incorporation on product during storage was found to be the non significant. The interaction was also found to be non significant.

There was a decrease in L* value which was significant when the product was stored. The intensity of darkness was slightly decreased in stored samples might be due to slight oxidation of HMF (caramalization) by head space oxygen in the product during storage. The interaction was found to be non significant between treatment and storage. The a* values were negative, hence the products having greenish pinch and intensity was significantly increased with increased incorporation of inulin same as fresh samples. The intensity of green colour decreased significantly during storage. During the storage the value of b* decreased slightly and storage mean value ranged from 16.77 to 16.73. The interaction of treatment and storage could not affect the colour of the product. These results of colour in terms of L*, a* and b* were agreement with Jovanka (2008) who reported colour changes in UHT milk during storage. Furthermore, According to Lee *et al.* (1998), this change of color is probably induced by simultaneous degradation of the yellowish-green colored riboflavin (vitamin B2), β-carotene molecules.

Effect of inulin incorporation on the chemical composition of fresh as well as stored inulin enriched sterilized fortified flavoured milk drink

Effect of different level of inulin incorporation on the chemical composition of fresh as well as stored IESFFMD is presented in Table 3 & 4. All chemical composition data are in the percent units, which do not, follows normal distribution, therefore to validate the test, the percentage data on chemical composition were subjected to "arcsine transformation" and subsequently analysis of variance was performed.

The data revealed that there was a significant difference in fat content when inulin was incorporated at different levels. Physically milk fat was partially replaced with inulin and this might have naturally contributed to the difference in the fat content among these samples. TS content among control and experimental samples ranged from 18.474 (T_0) to 18.678 (T_3) per cent. Though the levels of inulin incorporation increased, the total solids content did not differ significantly among these samples of IESFFMD. The protein contents of milk drink gradually increased with the increased incorporation of inulin and could be attributed to the replacement of milk fat with inulin that might have contributed to increase in the serum portion which is one of the sources of protein. The result of present findings on protein content is in agreement with Khalifa *et al.* (2011) reported that the protein increased in inulin incorporated yoghurt as compared to control.

The carbohydrate contents of IESFFMD also increased with increased incorporation of inulin. This might be ascribed to the fact that inulin itself is a soluble carbohydrate and its incorporation would

Table 3
Effect of inulin incorporation on chemical composition of fresh as well as stored inulin enriched sterilized fortified flavoured milk drink

Treatment	*Arcsine Transformed Value*								
	Fat			*TS*			*Protein*		
	Fresh	*Stored*	*Treat. mean*	*Fresh*	*Stored*	*Treat. mean*	*Fresh*	*Stored*	*Treatment mean*
T0	10.05 (3.05)	10.00 (3.04)	10.03^{D}	25.45 (18.47)	25.45 (18.47)	25.4460	10.99 (3.64)	11.00 (3.64)	11.00^{A}
T1	8.17 (2.02)	8.21 (2.03)	8.19^{C}	25.51 (18.56)	25.51 (18.55)	25.5059	11.13 (3.72)	11.13 (3.73)	11.13^{B}
T2	5.78 (1.02)	5.79 (1.01)	5.78^{B}	25.55 (18.62)	25.54 (18.61)	25.5526	11.37 (3.88)	11.39 (3.89)	11.38^{C}
T3	1.50 (0.12)	2.11 (0.12)	1.81^{A}	25.59 (18.68)	25.59 (18.67)	25.5958	11.50 (3.97)	11.50 (3.98)	11.50^{D}
Storage Mean	6.37	6.53	-	25.52	25.53	-	11.25	11.26	-
S Em	0.2683 (TS)	0.1341 (S)	0.1940 (T)	0.0002 (TS)	0.0001 (S)	0.0021 (T)	0.0047 (TS)	0.0024 (S)	0.0107 (T)
CD	NS (TxS)	NS (S)	0.5978** (T)	NS (TxS)	NS (S)	NS (T)	NS (TxS)	NS (S)	0.0329** (T)

Note: **- significant at 1% level of significance, The bracketed values are corresponding percent values

The superscript A, B, C,…… are indicate the comparison of variables with respect to inulin incorporation levels based on the LSD values

Table 4
Effect of inulin incorporation on chemical composition (carbohydrate, ash and Acidity) inulin enriched sterilized fortified flavoured milk drink after accelerated storage at 55° C for 5 days

Treatment	*Arcsine Transformed Value*								
	Carbohydrate			*Ash*			*Acidity*		
	Fresh	*Stored*	*Treat. mean*	*Fresh*	*Stored*	*Treat.mean*	*Fresh*	*Stored*	*Treat. mean*
T0	19.47 (11.12)	19.49 (11.11)	19.48^{A}	4.68 (0.67)	4.69 (0.67)	4.69^{A}	2.22 (0.150)	2.32 (0.164)	**2.27**
T1	20.37 (12.13)	20.35 (12.13)	20.36^{B}	4.73 (0.68)	4.73 (0.68)	4.73^{B}	2.20 (0.148)	2.33 (0.168)	**2.27**
T2	21.14 (13.02)	21.13 (13.00)	21.14^{C}	4.76 (0.69)	4.76 (0.69)	4.76^{C}	2.22 (0.151)	2.36 (0.166)	**2.28**
T3	21.87 (13.88)	21.85 (13.88)	21.86^{D}	4.78 (0.70)	4.78 (0.70)	4.78^{D}	2.25 (0.154)	2.35 (0.168)	**2.29**
Storage Mean	25.52	25.53	-	4.74	4.74	-	2.22^{A}	2.34^{B}	-
S Em	0.0343 (TS)	0.0172 (S)	0.0406 (T)	0.0012 (TS)	0.0006 (S)	0.0023 (T)	0.0222 (TS)	0.0111 (S)	0.0250 (T)
CD	NS (TxS)	NS (S)	0.0329** (T)	NS (TS)	NS (S)	0.0072** (T)	NS (TxS)	0.0332** (S)	NS (T)

Note: **- significant at 1% level of significance. The superscript A, B, C,…… are indicate the comparision of variables with respect to inulin incorporation levels based on the LSD values

have resulted in higher levels of carbohydrate. The results in alignment with the findings of Mittal and Bajwa (2012) reported that the carbohydrate contents increased with higher inulin addition in low calorie milk drink. The significant increase in the ash contents in IESFFMD as compared to control could be associated to contribution of mineral and metal elements of inulin. The results are in alignment with Mittal and Bajwa (2012) recorded increased ash content of sugar replaced low calorie milk drink. The level of inulin incorporation did not influence the acidity of the IESFFMD sample as well as control as evident from the non significant results obtained for this parameter. The results are in agreement with Mittal and Bajwa (2012) who reported that sugar replacement in low calorie milk drink did not influence the acidity of the product.

In storage condition the mean value of total solids among treatment was found to be non significant. The storage mean and and interaction between treatment and storage could not influenced by the inulin incorporation at all levels. During the storage there was a non significant effect on protein content and this result was in agreement with Khalifa *et al.* (2011) reported that the protein content was increased with the addition of inulin in yoghurt with control and could not influence with storage. The storage and treatment interaction also could not affected by the inulin incorporation. There was a non significant effect on carbohydrate content of IESFFMD during storage and interaction also not affect the carbohydrate content of stored product. The storage and interaction between treatment and storage were found to be non significant and could not affect the ash content of stored samples.

There was a slight increase in acidity which was significant when the product was subjected to accelerated storage as compare to fresh. The increase

in acidity during storage of IESFFMD could be attributed to increase in the concentration of free fatty acids, lactic acid and other organic acids that resulted from degradation of milk components mainly lactose and also inulin. Changes in calcium phosphate equilibrium might also be responsible for increased acidity of stored UHT milk (Rahman and Salariya, 2005). The interaction could not affect the acidity of the product.

Effect of inulin incorporation on microbiological characteristics of fresh as well as after stored inulin enriched sterilized fortified flavoured milk drink

The fresh as well as after accelerated storage at 55° C for 5 days samples of IESFFMD were analyzed for spore forming bacteria and showed in Table 5. The table revealed that there is no spore former observed in any of the sample. The results further revealed that all products have undergone the better sterilization treatment and are within the BIS standards.

Table 5
Effect of inulin incorporation on microbiological characteristics of fresh as well as stored inulin enriched sterilized fortified flavoured milk drink

Treatment	*Spore formers (cfu/ml)*
T_0	Nil
T_1	Nil
T_2	Nil
T_3	Nil

These results are in accordance with Hassan *et al.* (2009) recorded absence of spore forming bacteria in UHT milk. Tekinsen *et al.* (2007) also reported that in sterilized milk microbial growth after processing remained absent and found no spore forming organism in UHT milk. Sahoo *et al.* (2003) found the zero number of residual bacteria in sterilized milk immediately after processing and throughout storage period at two month.

Effect of inulin incorporation on sensory characteristics of fresh as well as stored inulin enriched sterilized fortified flavoured milk drink

The effect of level of inulin incorporation on the colour and appearance, flavour, mouth feel, sweetness and overall acceptability of fresh IESFFMD was evaluated on a 9- point Hedonic Scale by a panel of five judges and the data are presented in the Table 6 & 7.

It is evident from the Table 6 & 7, that the level of inulin incorporation did not show any significant effect on the colour and appearance scores among control and IESFFMD samples which is indicated by the non-significant results obtained for this parameter. The result of this study is in line with Aryana *et al.* (2007) reported that inulin addition did not show any effect in colour and appearance of the fat free plain yoghurt as compare to control. The level of inulin incorporation had significant effect on the flavour score. The higher flavour score in T_2 could be due to the perseverance of little caramelized flavour attributed to the participation of inulin (fructo oligosaccharides) which might have participated in caramalization in addition to sucrose and lactose present in the milk (Walstra and Jenness, 1984). Aryana *et al.* (2007) reported that the inulin containing yoghurt was found to have significantly higher flavour scores than control. The level of inulin incorporation had definite effect on the mouthfeel scores. The richness in mouthfeel could be attributed to the gelling properties of inulin which might have contributed to increase in the viscosity and is evident from the present findings on viscosity results presented in Table 2. The results are agreement Tarrega and Costell (2006) noticed in fat free dairy desserts that added inulin increased the thickness and creaminess as compare to the full fat milk samples. However as the level of inulin incorporation increased, the product became more viscous and secured lower scores due to the residual starchy mouthfeel perceived in the samples containing high inulin content.

Table 6
Effect of inulin incorporation on sensory scores of fresh and stored inulin enriched sterilized fortified flavoured milk drink

Treatment	*Colour and appearance*			*Flavour*			*Mouthfeel*		
	Fresh	*Stored*	*Treat mean*	*Fresh*	*Stored*	*Treatmean*	*Fresh*	*Stored*	*Treat mean*
T_0	7.36	7.28	7.32^{A}	7.52	7.44	7.48^{C}	7.6	7.48	7.54^{B}
T_1	7.48	7.16	7.32^{A}	7.24	7.24	7.24^{B}	7.04	6.8	6.92^{A}
T_2	7.84	7.68	7.76^{B}	8.12	7.8	7.96^{D}	8.28	7.9	8.09^{C}
T_3	7.44	6.88	7.16^{A}	6.92	6.62	6.77^{A}	7.04	6.52	6.78^{A}
Storage Mean	7.53^{B}	7.25^{A}		7.45	7.27		7.49	7.18	
S Em	0.1285 (TxS)	0.0642 (S)	0.0766 (T)	0.1058 (TxS)	0.0529 (S)	0.0745 (T)	0.1600 (TxS)	0.0800 (S)	0.1086
CD	NS (TxS)	0.19** (S)	0.24** (T)	NS (TxS)	NS (S)	0.23** (T)	NS (TxS)	0.24** (S)	0.34 (T)

** Significant at 1 per cent level. The superscript A, B, C,…… are indicate the comparison of variables with respect to inulin incorporation levels based on the LSD values

Table 7
Effect of inulin incorporation on sensory characteristics of fresh and stored inulin enriched sterilized fortified flavoured milk drink

Treatment	*Sweetness*			*Overall Acceptability*		
	Fresh	*Stored*	*Treatment mean*	*Fresh*	*Stored*	*Treatmentmean*
T0	7.52	7.28	7.40^{A}	7.64	7.48	7.56^{B}
T1	7.28	7.12	7.20^{A}	7.12	7.08	7.10^{A}
T2	7.88	7.52	7.70^{B}	8.44	8.01	8.23^{C}
T3	7.28	7.12	7.20^{A}	7.2	6.72	6.96^{A}
Storage Mean	7.49^{B}	7.26^{A}		7.60^{B}	7.32^{A}	
S Em	0.1131(TS)	0.0566 (S)	0.0689 (T)	0.1095 (TS)	0.0548 (S)	0.0910 (T)
CD	NS (TxS)	0.17** (S)	0.21** (T)	NS (TxS)	0.16* (S)	0.28** (T)

Note: **- significant at 1% level of significance

The superscript A, B, C,…… are indicate the comparison of variables with respect to inulin incorporation levels based on the LSD values

However the sugar addition was fixed (7%) in IESFFMD but there was a gradual increase in sweetness scores as the inulin addition increased up to 2% and there after it decreased (T_3). This might be due to the reason that the inulin itself is a carbohydrate (fructo oligosaccharides) and also used as a sugar replacer in various products (Wood 2011). The results are in line with Tarrega and Costell (2006) who observed increase in sweetness scores in fat-free starch-based dairy desserts as the level of inulin addition increased. The level of incorporation of inulin had a significant effect on overall acceptability scores including control. The highest score for overall acceptability of T_2 could be attributed with the fact

that basically it had secured the higher scores in colour and appearance, flavour, mouthfeel and sweetness that simultaneously reflected the overall acceptability score. The results are agreement with Tarrega and Costell (2006) who observed increased overall acceptability in the inulin added fat-free starch-based dairy desserts. Guven *et al.* (2005) also recorded the higher overall acceptability scores in inulin added yoghurt as compared to control yoghurt without inulin.

During storage the scores significantly decreased from 7.53 to 7.25. The decrease in the colour and appearance might be associated with the intensity of darkness which slightly decreased in stored samples due to slight oxidation of HMF (caramalization) by head space oxygen in the product during storage. Rehman and Salariya (2005) observed deterioration in colour score of UHT milk during storage at 40°C. The interaction also showed non significant effect. Among the stored IESFFMD T_2 had the highest score of 7.84 which significantly differed from the rest of the samples including control. The decrease in flavour score might be ascribed to minor decomposition of milk constituents that would have occur at 55°C for 5 days. The results are in lined with the results of Rehman and Salariya (2005) observed slightly decreased flavour score in UHT milk during storage at 40°C. The interaction between the treatment and storage was found to be non significant. Initially the T_2 fresh samples had secured the highest mouthfeel score and it continued to secure higher score during storage indicating that this product has undergone minimal change even after accelerated storage. The stored samples showed slightly lower mouthfeel scores because the viscosity of the sample also decreased in storage condition as evident from Table 2. The results are agreement with Mohammedali *et al.* (2013) recorded the decrease in texture score in retort processed ready-to-drink traditional Thari Kanchi payasam when stored at 45°C. The interaction effect was found to be non significant. During storage the sweetness scores slightly decreased from 7.49 to 7.26 for fresh and stored samples respectively. The interaction between treatment and storage were found to be non significant. In absence of related literature the results of present study could not be compared for the stored product. However the decrease in sweetness score might be due to the masking effect by acidity as evident from Table 3.

The overall acceptability scores during storage slightly decreased from 7.60 to 7.32. The results are in lined with Mohammedali *et al.* (2013) recorded the decrease in overall acceptability score in retort processed ready-to-drink traditional Thari Kanchi payasam when stored at 45°C. Rehman and Salariya (2005) also observed slight decrease in overall acceptability score in UHT milk during storage at 40°C. Though the scores decreased in all treatments during storage, they secured more than 6 out of 9 on hedonic scale indicating the product remained acceptable even after storage at 55° C for 5 days and the performance of T_2 was found superior than control T_0.

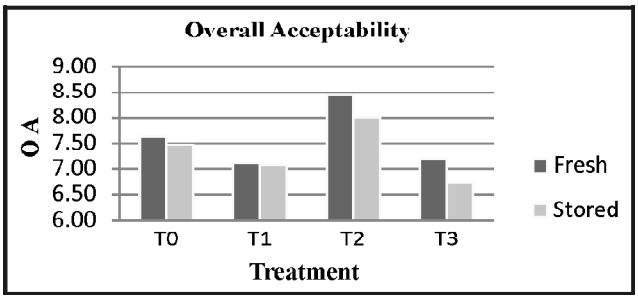

Figure 2: Effect of inulin incorporation on the overall acceptability of fresh and stored inulin enriched sterilized fortified flavoured milk drink

Estimation of production cost of inulin enriched sterilized fortified flavoured milk drink

The production cost involved in the manufacture of IESFFMD was calculated based on the variable costs of raw materials, processing, packaging and labour costs. The production cost at various levels of replacement has been calculated in order to

evaluate the actual cost of each treatment during the manufacture of IESFFMD. The production cost per 200 g of the product was estimated to be 12.70 (T_0), 12.15 (T_1), 11.62 (T_2) and 11.25 (T_3). On comparing, the T_3 had the lowest production cost with a difference of Rs.1.40 as compared to control (T_0). All IESFFMD samples had lower production cost then control and could be due to the basic difference in the price of inulin and milk fat. Furthermore skim milk was also used which had lower cost per litre.

CONCLUSION

Inulin could be very well used to incorporate or replace milk fat for the preparation of sterilized fortified flavoured milk drink. Inulin incorporation resulted in higher specific gravity, viscosity, total solids and protein, carbohydrate, ash and color values in fresh as well as accelerated stored samples. Microbiologically all fresh and accelerated stored samples were sterile. The sensory scores were influenced by inulin incorporation and the sample containing 2% inulin and 1% milk fat was most acceptable and secured the highest scores for flavour, mouthfeel, sweetness and overall acceptability even after accelerated storage. The production cost of the product could be reduced through inulin incorporation in the preparation of the product.

Therefore it can be concluded that the 2% inulin and 1% milk fat could be used to develop a sterilized fortified flavoured milk drink with better physical, chemical, microbiological and sensory quality with reduced production cost as compare to control.

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