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Amaranth and Date Flavoured Milk

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ABSTRACT

Background: This project is aimed at developing a milk-based beverage combining the nutrient properties of milk, amaranth and dates. Inclusion of amaranth and dates in flavoured milk could provide product diversification and benefits to the health-conscious consumers. The objective of the present study was to develop a procedure for manufacture of an amaranth date flavoured milk (ADFM) using amaranth and date.

Methods: To select the level of fat in milk, four batches of ADFM were prepared from milks containing different levels of milk fat *viz*. F1 (4.5%), F2 (3.0%), F3 (1.5%) and F4 (0.1%). To carry out their optimization in the final product formulation, the data was analysed using response surface methodology (RSM) using an advanced statistical software program named design expert (Version 8.0.3) was employed.

Result: On the basis of overall acceptability score, ADFM prepared from milk containing fat at 3.0% fat was preferred the most. From amongst different types and levels of stabilizing salts it was found that addition of 0.15% sodium citrate prevented coagulation during sterilization. The levels of roasted amaranth flour (% w/w of milk), date extract (% w/w of milk) and sugar (% w/w of milk) for preparation of ADFM was optimized using RSM with CCRD using three independent variables. The suggested solution from RSM analysis for ADFM was: level of roasted amaranth flour: 1.61% w/w of milk, level of date extract: 5.16% w/w of milk and sugar: 6.0% w/w of milk. The developed product has 20.83% total solid, 2.77% fat, 3.07% protein, 14.15% carbohydrate, and 0.84% ash. Results of the study revealed that an acceptable quality ADFM can be manufactured by incorporating roasted amaranth and date.

Key words: Amaranth, Date, Date extract, Flavoured milk, Roasted amaranth flour, Response surface methodology.

INTRODUCTION

According to FSSAI (2011), “Flavoured Milk” means the product prepared from milk or other products derived from milk, or both and edible flavouring with or without addition of sugar, nutritive sweeteners, other non-dairy ingredients including, stabilizer and food colour. Where flavoured milk is dried or concentrated, the dried or concentrated product on addition of prescribed amount of water shall give a product conforming to the requirements of flavoured milk. Permitted ingredients include: Sugar or other nutritive sweeteners or both (ii) Other non-dairy ingredients like nuts (whole, fragmented or ground), cocoa solids, chocolate, coffee, fruits and vegetables and products thereof including juices, purees, pulps, preparations and preserves derived therefrom, cereals and cereal products and cereal based extracts, honey, spices, condiments, salt and other natural flavouring foods and flavours.

Because of the increase in demand of liquid milk products there is a stiff competition amongst manufacturers to manufacture new varieties of flavoured milks. These days, consumers are more health and quality oriented and also willing to pay premium prices for innovative products. Moreover, milk per se has certain limitations like allerginicity, lactose intolerance, cholesterol, saturated fat content, *etc.* With advancement in technology, several dairy derived ingredients are being produced that when used in conjunction with other food ingredients in food manufacture can yield ‘value-added’ products that have balanced nutrition and exhibiting superior functionalities as well as ‘wellness’ in food application (Krupa and Patel, 2011). Therefore, new varieties of flavoured milks are being developed targeting the palate and health intention of consumers. Milk beverages are considered among the most functional and nutritional foods (Bangar, 2011).

Amaranth, commonly known as rajgira (king seed), ramdana (seed sent by God) is known to be a very nutritious pseudo-cereal with an exceptionally high protein content as compared to the true cereals (Escudero *et al.,* 2006). The health benefits attributed include decreasing plasma cholesterol levels, stimulating the immune system, exerting an antitumor activity, reducing blood glucose levels and improving conditions of hypertension and anemia. In addition, it has been reported to have anti-allergic and antioxidant activities (Caselato-Sousa and Amaya-Farfan, 2012).

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The date fruits have been recognized for their highly nutritive, well mineralized, highly flavoured and high calorific food value and it's also a good source of dietary fiber (Chandra *et al.,* 1992). Date contain a high percentage of carbohydrate (44-88%), fat (0.2-0.5%), protein (2.3-5.6%), vitamins and a high percentage of dietary fiber (6.4-11.5%) (Al-Shahib and Marshall, 2003).

This project is aimed at developing a milk based beverage combining the nutrient properties of milk, amaranth and dates. Inclusion of amaranth and dates in flavoured milk could provide product diversification and benefits to the health-conscious consumers. The objective of the present study was to develop a procedure for manufacture of an ADFM using amaranth and date.

MATERIALS AND METHODS

Raw materials

Fresh, raw mixed (cow and buffalo) milk was procured from Anubhav Dairy, Anand and standardized to 3.0% fat and 8.5% SNF by mixing required quantity of skim milk and cream. The average composition of milk was 3.1+0.05% fat and 8.6+0.05% MSNF. Cane sugar (Madhur Brand, M/s Shree Renuka Sugars Ltd., Amaranth grain (Arena organica, Arena organica Pvt Ltd., Sikar, Rajasthan; Deseeded dates (Apis Brand, Apis India Ltd., New Delhi; was used for preparation of ADFM.

Preparation of roasted amaranth paste

Amaranth seed were roasted in a SS karahi (0.5 mm thickness) at 110°C for 10 to 12 min. cooled to room temperature and ground to obtain amaranth flour. Roasted amaranth flour was mixed with milk (1:20 parts) for making the paste. The paste was heated at 70°C for 5 min for proper blending and gelatinization and cooled to room temperature.

Preparation of date extract

The dates were sorted, cleaned thoroughly and deseeded. The deseeded date and equal amount of water is taken in stainless steel vessel. The date was heated in water at 100°C for 2 to 3 min and keeping the dates in same hot water for 1 h. Grinding of date to fine paste and strained through fine wire mesh to obtain date extract, which stored at refrigeration temperature (7±2°C) till use.

Preparation of ADFM

ADFM were prepared from milks containing different levels of milk fat *viz.* F1 (4.5%), F2 (3.0%), F3 (1.5%), F4 (0.1%). These levels were decided based on preliminary trials. Date extract was added in all the experimental samples @ 10.0% (w/w of milk) and sugar was added @ 5.0% (w/w of milk). Stabilizing salt *i.e.* trisodium citrate was added in all the four experimental samples @ 0.15% (w/w of milk). All the experimental samples prepared during this part of the investigation were also subjected to sensory evaluation which was carried out by a panel of 10 judges.

ADFM was prepared using different levels of roasted amaranth flour, level of date extract and sugar as suggested by response surface methodology (RSM) to choose the best combination to get the most acceptable ADFM. The level of roasted amaranth ranging from (A) 1.25 to 2.0 (% w/w of milk), level of date extract (B) and sugar (C) was selected which ranged from 4 to 6 (% w/w of milk) and 5 to 7 (% w/w of milk) respectively. The solutions were optimized by adopting a three factor Central Composite Rotatable Design (CCRD) consisting of total 20 experiments (Table 4).

Milk standardized to 3.0% fat and 8.5% MSNF was heated to 60°C prior to homogenization (2500+500 psi). Roasted amaranth flour was added in the form of a paste. Amaranth seeds were roasted at 110°C for 10 to 12 min, cooled and ground to a fine flour. The roasted amaranth flour and milk were mixed @ 1:20 parts for making the paste. The paste was heated at 70°C and cool to room temperature. Date extract (% w/w of milk), roasted amaranth flour (% w/w of milk), tri sodium citrate (%) and sugar (% w/w of milk) were added and stirred for one min. The milk was blended by heating at 70°C to 5 min. The product was filled in 200 ml sterilized glass bottles and sterilized at 121°C for 15 min. The bottles were stored at room temperature *i.e.* 37°C.

Sensory evaluation

The flavoured milk subjected to sensory evaluation by a panel of 10 members comprising of faculty members from the college. The sensory attributes evaluated were colour and appearance, body (mouth feel), flavour, sweetness and overall acceptability score, based on 9-point hedonic scale. The flavoured milk samples were served in 50 ml glass beakers. The containers were labelled with random digit codes. The order of presentation of samples to the judges was randomized. Sensory evaluation of the product was conducted in isolated booths, illuminated with incandescent light in sensory evaluation lab maintained at 23±2°C. The panelists were instructed to use lukewarm water as a rinsing media, between samples, as and when required.

Physico-chemical analysis

The fat content of flavoured milk was estimated by Gerber method (BIS, 1977). The total solids (TS) of flavoured milk was determined by the standard procedure (BIS, 1989) using Mojonnier Milk Tester (Model-D, Mojonnier Brothers Co., Chicago, USA). The protein content was determined using semi-micro Kjeldahl method (Jayaraman 1981). The ash content of all the flavoured milk samples was determined by standard method (BIS, 1989). The pH values of flavoured milk samples were measured using electronic digital pH meter (M/s. Mettler Toledo AG, Schwerzenbach, Model CH-8603). The viscosity of flavoured milk was measured at 20°C using a 'Brookfield' viscometer (DV II + Pro Viscometer, Model- LVDV- II + P, USA). Sediment value in the flavoured milk was measured by centrifugation method, using calibrated centrifuge tubes (50 mL). The weight of centrifuge tube was recorded and milk was weighted in them. The samples were placed in a centrifuge (Remi laboratory centrifuge machine) operated at 3000 rpm for 15 min. After centrifugation, the solid sediments were separated from the supernatant by decanting. The tubes were then placed in an oven at 120°C for 36 h and the dry weight of sediment was noted. The results were expressed as g of sediment/ 100g of milk (Prakash *et al.*, 2010).

Statistical analysis

Completely randomized design (CRD) was used for analysis of data in selection of level of fat in milk. To carry out their optimization in the final product formulation, the data was analysed using Response Surface Methodology (RSM) using an advanced statistical software program named Design Expert (Version 8.0.3) was employed.

RESULTS AND DISCUSSION

ADFM was prepared according to the method and it was found that all the experimental samples coagulated during sterilization. Therefore, it was decided to add stabilizing salts. Preliminary studies were conducted to select the type of stabilizing salts from amongst trisodium citrate and disodium hydrogen orthophosphate.

To select the optimum blend of stabilizing salts formulation, six batches of ADFM *viz.* F1, F2, F3, F4, F5 and F6 were prepared having different combinations and levels of stabilizing salts as shown in Table 1. These levels were decided based on preliminary trials.

Date extract was added @ 10% (w/w of milk), sugar was added @ 5.0% (w/w of milk) and roasted amaranth flour @ 3% (w/w of milk). All the experimental samples were subjected to sensory evaluation by a panel of 10 judges. The effect of type and level of stabilizing salts on acceptability of date milk beverage is presented in Table 2.

Table 1: Type and level of stabilizing salts.

Sample	Stabilizing salts	Level of addition (% w/w of milk)
F1	Trisodium citrate	0.05
F2	Trisodium citrate	0.10
F3	Trisodium citrate	0.15
F4	Trisodium citrate	0.20
F5	Trisodium citrate: Disodium hydrogen orthophosphate (1:1)	0.10
F6	Trisodium citrate: Disodium hydrogen orthophosphate (1:1)	0.20

It was found that experimental samples F1, F2, F5 and F6 coagulated during sterilization. From this part of the study, it is evident that amongst all the different blends of emulsifying salts tried, F3 and F4 did not coagulate during sterilization. The level of salts used in F3 was 0.15 which was lower than F4 (*i.e.* 0.2%). Hence, ADFM made with addition of trisodium citrate @ 0.15% was selected for use in the latter part of this study.

Selection of level of fat in milk

This part of the study was carried out to select the preferred level of fat in milk for manufacture of ADFM. Four batches of ADFM were prepared using procedure described in Section 3.5 from milks containing different levels of milk fat *viz.* F1 (4.5%), F2 (3.0%), F3 (1.5%) and F4 (0.1%). All the samples were subjected to sensory evaluation which was carried out by a panel of 10 judges. The results presented in Table 3 represent the influence of level of fat in milk on the sensory characteristics of the ADFM *i.e.* scores for flavour, mouthfeel, colour and appearance, overall acceptability.

Influence of level of fat in milk on sensory characteristics of amaranth date flavoured milk

Flavour score

Flavour is a significant factor in assessing the acceptability of any product. High quality flavoured milk must be pleasantly sweet, suggest a creamy background sensation, exert a delicate flavour and possess a pleasant, rich aftertaste and should leave the mouth with a clean aftertaste. The average flavour scores of the experimental samples were in the range 7.78 (F1) to 6.53 (F4). Amongst all the experimental samples, F2 was adjudged the best. It can be seen from Table 3 that a decrease in milk fat resulted in decrease in flavour score at levels greater than and less than 3% fat level. The preference as per flavour score was in the order F2 (7.78) > F1 (7.26) > F3 (6.8) > F4 (5.53). The statistical analysis reveals that F2 had significantly ($P<0.05$) higher flavour score compared to all the other experimental samples studied. The flavour score of F4 was significantly ($P<0.05$) lesser than all the other experimental samples. The flavour score of F3 and F4 were adjudged to be at par ($P>0.05$) with each other.

Table 2: Effect of type and level of stabilizing salts on acceptability of ADFM.

Sample	Acceptability of sensory characteristics			
	Flavour	Mouthfeel	Colour and appearance	Overall acceptability
F1	-	-	-	-
F2	-	-	-	-
F3	+++	+++	+++	+++
F4	++	+++	+++	++
F5	-	-	-	-
F6	-	-	-	-

++++ Highly acceptable; +++ Acceptable; ++ moderately acceptable; + Slightly acceptable; - Not acceptable.

Experimental sample F3 and F4 containing fat at 1.5 and 0.1% level, was criticized for lacking in richness, creaminess, smoothness and was often criticized for its powdery taste. In this part of the study the samples containing fat at 3.0% level were displayed richness, creaminess, smoothness and mouth feel. Whereas sample containing 4.5% fat was criticized for being excessively viscous and flat flavour because the samples lacked the desired sweetness.

Richardson *et al.* (1993) concluded that the sensation of creaminess is the combination of small fat droplets and an adequately high viscosity. To be perceived as creamy, a smooth but viscous fluid layer is needed between the tongue and palate. Creaminess is a sensory attribute that is perceived through a complex pattern including perception of thickness, wateriness, friction, coarseness, mouth coating, oral tissue lubrication, *etc.* Fat enhances the flavour of whole milk by contributing naturally occurring flavour compounds that are removed from milk when fat is removed (Phillips *et al.* 1995b). These authors mentioned that the flavour and mouthfeel improved as the fat content of the milk raised from 0.06 to 2%. This might be due to the rich flavour imparted by fat. On the other hand, Li *et al.* (1997) observed that the variations in fat content (0 to 10 per cent) had no impact on the perception of sweetness. It has been suggested that the ability of carbohydrate based fat replacers to imitate the physical properties of milk fat is demarcated by the colloidal properties of the carbohydrate involved and their effects on mouth feel (Specter and Setser, 1994).

Mouthfeel score

Mouthfeel or consistency is an important criterion for the evaluation of flavoured milk. The average mouthfeel scores presented in Table 3 indicate that F2 had higher mouthfeel scores compared to other samples. F2 scored the highest marks for mouthfeel 7.96 followed by F1 (7.11). The preference as per Mouthfeel score was in the order F2 (7.96) > F1 (7.11) > F3 (6.75) > F4 (6.50). The statistical analysis reveals that F2 had significantly (P<0.05) higher mouthfeel score to other experimental samples studied. It can be seen form the Table 3 there was significant (P>0.05) difference between the mouthfeel scores of F2 and F1 sample. The mouthfeel score of F4 was significantly (P<0.05) lower than all the other experimental samples. The mouthfeel score of F3 and F4 were at par (P>0.05) with each other.

There was a slight decrease in mouthfeel scores at higher levels of fat content. This was because of the excessive viscosity in sample F1. Whereas, samples F3 and F4 lacked the desired mouthfeel because of lacking in consistency.

It was observed that the overall acceptability scores of the milk were marginally higher for samples with more fat *i.e.* F1 and F2. The results obtained in this study are in disagreement with those obtained by Mittal and Bajwa (2015) who did not find any improvement in the body and mouth feel score of low calorie mango flavoured milk drink with fat at 2.0, 1.0 and 0.5% levels. On the other hand, Phillips *et al.* (1995a) had reported that the flavour and mouthfeel increased as the fat content of the milk increased from 0.06 to 2.0%.

Colour and appearance score

The colour of flavoured milk should be appealing desirable and uniformly consistent without displaying any indication of noticeable foreign matter and any sedimentation. There should not be any fat layer on top neck of the bottle. Flavoured milk should have uniform appearance having an optimum consistency. The colour of amaranth date flavoured milk should be uniform, attractive light brown and pleasing in colour. The colour should be neither too pale nor too vivid. The average colour and appearance scores indicated in Table 3 reveal that F2 was preferred the most. The average range of colour and appearance scores was 7.50 (F2) to 7.43 (F3). The order of preference was in the sequence F1 (7.56)> F2 (7.50)> F4 (7.45) > F3 (7.45). There was no significant variability (P>0.05) in the colour and appearance scores between all the experimental samples.

These results are in contrast with those reported by Phillips *et al.* (1995a) who observed that an increase in fat content of milk from 0.06 to 2.0% caused a corresponding increase in its viscosity. Two % fat milk had a significantly higher colour and appearance score than that of 0.5 and 1.0 per cent fat milk. Miller *et al.* (2002) also stated appearance of whole milk and low fat milk differed greatly due to differences in fat concentration.

Table 3: Influence of level of fat in milk on sensory characteristics of ADFM.

Level of fat	Sensory score			
in milk (%)	Flavour	Mouthfeel	Colour and appearance	Overall acceptability
4.5 (F1)	$7.26^{b}\pm0.32$	$7.11^{b}\pm0.31$	7.56 ± 0.37	$7.30^{b}\pm0.13$
3.0 (F2)	$7.78^{a}\pm0.21$	$7.96^{a}\pm0.28$	7.50 ± 0.35	$7.80^{a}\pm0.16$
1.5 (F3)	$6.80^{c}\pm0.31$	$6.75^{c}\pm0.31$	7.43 ± 0.09	$6.72^{c}\pm0.15$
0.1 (F4)	$6.53^{c}\pm0.45$	$6.50^{c}\pm0.15$	7.45 ± 0.20	$6.58^{c}\pm0.19$
SEm	0.12	0.11	0.14	0.08
CD (0.05)	0.36	0.34	NS	0.24
CV%	3.30	3.07	3.75	2.17

Each observation is a mean±SD of 4 replicate experiments.

^{a,d}Different superscripts in each column indicate significant differences at 5% level of significance.

Overall acceptability score

The total scores provide an idea about the overall quality of the product and the related findings are addressed and delineated in this segment. The total scores given in Table 3 also reveal overall superiority of sample F2. The overall acceptability score of the experimental samples showed that F2 and F1 had acceptable sensory quality. The preference as per overall acceptability score was in the order F2 (7.80) > F1 (7.30) > F3 (6.72) > F4 (6.58). As seen in Table 3, the overall acceptability of sample F2 was considerably higher than all the other samples in relation to all the qualities studied, *i.e.* taste, mouthfeel, colour and appearance, overall acceptability scores.

The main purpose of this part of the study was to decide the level of fat in manufacture of ADFM with good overall sensory and physical characteristics. It can be seen from Table 3 that F2 maintained its superiority over all the other samples in relation to all the attributes covered in this section. It can be seen that the overall acceptability score of F2 was significantly ($P<0.05$) higher than the all the other levels studied. On the basis of overall acceptability score, ADFM prepared from milk containing fat at 3.0% level was preferred the most. Hence this level was selected and employed in the remaining part of the study.

Optimization of parameters for amaranth date flavoured milk

All the 20 batches of ADFM were evaluated for their sensory attributes. The results of the study obtained for sensory scores of ADFM are presented in Table 4. The regression analysis of suggested models for sensory scores of amaranth date flavoured milk is presented in Table 5.

Effect of level of amaranth, date extract and sugar on sensory score of amaranth date flavoured milk

As seen in Table 5 that the calculated F values are more than the Table F values at 5% level of significance which indicate the significance of the model terms. It can also be seen that, the coefficient of determination (R^2) which reflects the proportion of variability in data explained or accounted by the model F values for flavour, colour and appearance, mouthfeel, sweetness and overall acceptability 4.87, 5.51, 4.99, 4.57 and 7.74 were respectively. A larger R^2 values suggest a better fit of the quadratic model. The Adequate Precision Value (APV) measure the signal to noise ratio. As seen in Table 5, the APV for sensory characteristics were greater than 4, which support the suitability of the model to navigate the design.

Flavour score

The flavour score of ADFM ranged from 7.85 to 8.54 showed in Table 4. The level of amaranth (A^2) and level of date extract (B^2) shows significant ($P<0.05$) negative effect on flavour score and level of sugar (C^2) had non-significant ($P>0.05$) negative effect on flavour score at quadratic level.

In similar studies, Gad *et al.* (2010) reported an increase in flavour scores in functional yogurt prepared using a combination of date palm syrup and skim milk. Their results showed that yogurt enriched with 10% date syrup had increased flavour score as compare to control yoghurt.

Table 4: Experimental design matrix for sensory score of ADFM.

Run order	Level of amaranth (% w/w of milk) (A)	Level of date extract (% w/w of milk) (B)	Level of sugar (% w/w of milk) (C)	Sensory score				
				Flavour	Colour and appearance	Mouthfeel	Sweetness	Overall acceptability
1	2.00	6.00	7.00	8.13	8.16	8.14	8.20	8.10
2	1.25	6.00	5.00	8.20	8.22	8.25	8.28	8.21
3	1.63	5.00	4.32	8.51	8.49	8.52	8.44	8.49
4	1.25	4.00	5.00	8.24	8.27	8.21	8.24	8.21
5	2.00	4.00	7.00	8.16	8.12	8.18	8.11	8.13
6	1.63	5.00	6.00	8.52	8.47	8.51	8.47	8.48
7	2.26	5.00	6.00	8.10	8.02	7.99	8.05	7.96
8	1.63	5.00	6.00	8.50	8.48	8.53	8.46	8.48
9	1.63	6.68	6.00	8.45	8.42	8.41	8.37	8.40
10	1.63	5.00	6.00	8.52	8.51	8.54	8.46	8.51
11	0.99	5.00	6.00	7.85	7.77	7.81	7.88	7.82
12	1.63	5.00	6.00	8.54	8.54	8.50	8.47	8.54
13	1.63	5.00	7.68	8.13	8.19	8.20	8.22	8.12
14	2.00	4.00	5.00	8.11	8.15	8.12	8.18	8.06
15	1.25	4.00	7.00	8.23	8.22	8.28	8.29	8.20
16	1.63	5.00	6.00	8.47	8.48	8.49	8.46	8.46
17	2.00	6.00	5.00	8.10	8.17	8.12	8.16	8.10
18	1.63	3.32	6.00	8.31	8.23	8.26	8.25	8.25
19	1.63	5.00	6.00	8.49	8.46	8.50	8.48	8.47
20	1.25	6.00	7.00	8.18	8.19	8.18	8.21	8.17

However, the results obtained in this study are in contrast to those reported by Keshtkaran and Mohammadifar (2013). They reported that date flavoured milk prepared from date syrup (5 to 25% w/w) and gum tragacanth (0.1 to 0.3% w/w) the flavour score was decreased. Surve *et al.* (2017) prepared milk shake by incorporation of date (*Phoenix dactylifera* L.) and jaggery. The levels of date pulp were 5, 10, 15% and jaggery at the rate 4, 5, 6% of milk. The score increased up to 10% level of date pulp then decreased with addition of 15 percent level of date pulp.

Vasquez Orejarena (2016) reported that with increase in level of oat there was an increase in flavour score of high protein dairy beverage prepared from oat and milk protein isolate. The oat added milk drink with 1.5% oat flour had obtained highest score for flavour as compared to other experimental and control samples. The flavour scores increased which may be due to the complex collection of volatile flavour components in oat flour.

Tiwari *et al.* (2018) prepared oat added milk drink by incorporation of oat and sugar. The levels of oat were 0.5, 1.0, 1.5 per cent and sugar at the rate 7% of milk. They reported that as the level of oat flour increased, the flavour score also increased up to 1.5% level of oat.

Colour and appearance score

The colour and appearance scores of ADFM depicted in Table 4 indicated variation from 7.77 to 8.54. The extremely higher level of amaranth (A^2) and level of date extract (B^2) showed significant (P<0.05) negative effect on colour and appearance score of ADFM at quadratic level. The level of sugar (C^2) showed non-significant (P>0.05) negative effect on colour and appearance score of ADFM at quadratic level.

The results obtained in this part of the study are in agreement with those obtained by Keshtkaran and Mohammadifar (2013) who reported that date flavoured milk prepared from date syrup (5 to 25% w/w) and gum tragacanth (0.1 to 0.3% w/w) the colour and appearance score increased. Surve *et al.* (2017) prepared milk shake by incorporation of date (*Phoenix dactylifera* L.) and jaggery. The colour an appearance score increased up to 10% level of date pulp then decreased with addition of 15 per cent level of date pulp.

However, the results obtained in this study are in contrast to those reported by Gad *et al.* (2010) who reported that functional yogurt prepared from combination of date palm syrup and skim milk showed that yogurt enriched with 10% date syrup had a decreased colour and appearance score as compare to control yoghurt.

Tiwari *et al.* (2018) prepared oat added milk drink by addition of oat and sugar. The levels of oat were 0.5, 1.0, 1.5 per cent and sugar at 7% of milk. They reported that level of oat flour increased, the colour and appearance score increased.

Mouthfeel score

The mouthfeel scores of ADFM depicted in Table 4 indicated variation from 7.81 to 8.54. The level of amaranth (A^2) shows significant (P<0.01) negative effect on mouthfeel score and level of date extract (B^2) had shown significant (P<0.05) negative effect on mouthfeel score at quadratic level (Table 5). The level of sugar (C^2) shows non-significant (P>0.05) negative effect on mouthfeel score.

Vasquez Orejarena, (2016) reported that with increase in level of oat there was the formulations correlated negatively with the mouthfeel acceptability; the more solids the less acceptable the beverage and an decrease in mouthfeel score of high protein dairy beverage prepared from oat and milk protein isolate.

Similar observations reported by Tiwari *et al.* (2018) prepared oat added milk drink by addition of oat and sugar. The result obtained from this work indicated that the addition

Table 5: P values and partial coefficients of regression equation of suggested models for sensory score of ADFM.

Parameter		Flavour[1]	C and A[1]	Mouthfeel[1]	Sweetness[1]	Overall acceptability[1]
Intercept		8.51	8.49	8.51	8.47	8.49
Linear level	A	-0.0124	-0.0110	-0.0247	-0.0340	-0.0252
	B	0.0185	0.0332	0.0229	0.0361	0.0288
	C	0.0046	-0.0122	0.0090	0.0130	0.0010
Interactive effect	AB	0.0237	0.0288	0.0100	0.0263	0.0200
	AC	0.0312	0.0163	0.0175	0.0113	0.0300
	BC	-0.0013	0.0088	-0.0050	-0.0012	-0.0025
Quadratic level	A^2	-0.1957*	-0.2018*	-0.2065*	-0.1702*	-0.2118*
	B^2	-0.0790**	-0.0745**	-0.0863**	-0.0712**	-0.0810**
	C^2	-0.0472	-0.0374	-0.0333	-0.0288	-0.0403
R^2		0.8142	0.8322	0.8180	0.8043	0.8745
Model F-value		4.87	5.51	4.99	4.57	7.74
APV		6.77	7.22	7.09	6.88	8.84
Suggested model		Quadratic	Quadratic	Quadratic	Quadratic	Quadratic

*Significant 1% level (P<0.01); **Significant at 5% level (P<0.05); R^2 coefficient of determination; APV: Adequate precision value; A, B and C refer to the level of amaranth (% w/w of milk), date extract (% w/w of milk) and sugar (% w/w of milk); [1]Sensory score on 9 point hedonic scale.

of oat flour above 1.0% concentration may produce somewhat highly viscous products which ultimately results in the development of the milk drink which lacks in the desirable consistency.

Sweetness score

The sweetness score of ADFM depicted in Table 4 indicated variation from 7.88 to 8.48. The level of amaranth showed non-significant (P>0.05) negative effect on sweetness score. Also at higher levels of amaranth (A^2), level of date extract (B^2) and level of sugar (C^2) showed significant (P<0.01) negative effect on sweetness score at quadratic level. The interaction effect of level of amaranth and level of sugar (AC) and interaction effect between level of amaranth and level of date extract showed non-significant (P>0.05) positive effect on sweetness score of ADFM.

Gad *et al.* (2010) prepared functional yogurt from combination of date palm syrup and skim milk. Author reported that yogurt enriched with 10% date syrup had an increased sweetness score as compare to control yoghurt.

Overall acceptability score

The overall acceptability score of ADFM depicted in Table 4 indicated variation from 7.82 to 8.54. The higher levels of amaranth (A^2), level of date extract (B^2) and level of sugar (C^2) showed significant (P>0.01) negative effect on overall acceptability score. The interaction of level of amaranth and level of date extract (AB) showed non-significant (P>0.05) positive effect on overall acceptability score of ADFM (Fig 1). The interaction effect between level of amaranth and level of sugar (AC) had non-significant (P>0.05) positive effect on overall acceptability score (Fig 2). The interaction effect between level of date extract and level of sugar (BC) had non-significant (P>0.05) negative effect on overall acceptability score (Fig 3).

Gad *et al.* (2010) observed that yogurt enriched with 10% date syrup had an increased overall acceptability score as compare to control yoghurt.

Vasquez Orejarena (2016) reported overall acceptability scores was significantly increased for samples in oat added beverage. The increase in viscosity is one of the main concerns when including a large amount of oat and protein in the beverage. High viscous beverages are difficult to swallow, which might result in a poor acceptability. Surve *et al.* (2017) prepared milk shake by incorporation of date (*Phoenix dactylifera* L.) and jaggery. The overall acceptability score increased up to 10% level of date pulp then decreased with addition of 15 per cent level of date pulp for the product.

Tiwari *et al.* (2018) prepared oat added milk drink by addition of oat and sugar. The overall acceptability scores was significantly increased for oat added milk drink. The level of addition of oat flour had considerable effect on overall acceptability scores of oat added milk drinks.

Optimization of amaranth date flavoured milk

Process optimization for the development of ADFM was carried out with the objective of determining the best possible

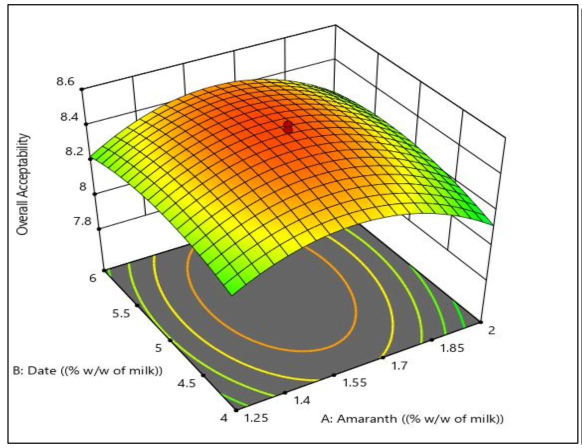

Fig 1: Response surface of overall acceptability as influenced by (A) level of amaranth (% w/w of milk) and (B) level of date extract (% w/w of milk).

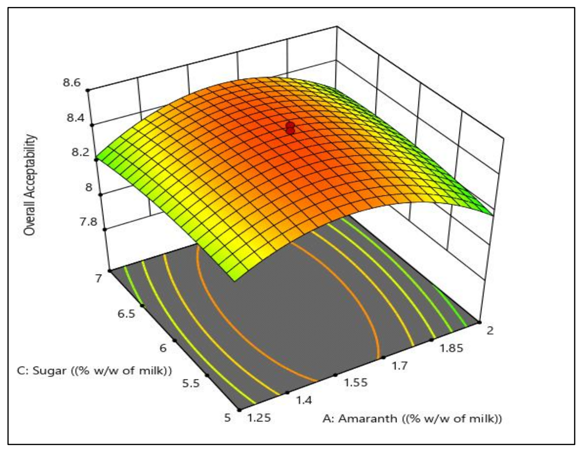

Fig 2: Response surface of overall acceptability as influenced by (A) level of amaranth (% w/w of milk) and (C) sugar (% w/w of milk).

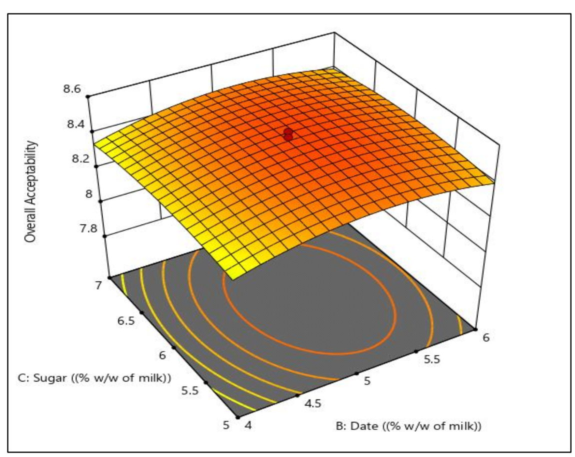

Fig 3: Response surface of overall acceptability as influenced by (B) level of date extract (% w/w of milk) and (C) level of sugar (% w/w of milk).

Table 6: Comparison of predicted v/s actual values of responses selected.

Response	P value	Predicted value*	Actual value@	Cal. t-value#	Significance
Flavour[1]	0.1109	8.51	8.49	1.8682	NS
Colour and appearance[1]	0.1512	8.49	8.47	1.6439	NS
Mouthfeel[1]	0.3018	8.51	8.49	1.1313	NS
Sweetness[1]	0.8382	8.47	8.46	0.2132	NS
Overall acceptability[1]	0.1030	8.49	8.47	1.9215	NS

[1]Sensory score on 9 point hedonic scale; *Predicted values of design expert 8.0.3 package; @Actual values are average of seven trials of optimized product; #t-values found non-significant at 5% level of significance; NS = Non-significant; Tabulated t-value = 2.447 (Calculated t-value less than tabulated value).

Table 7: Proximate composition of amaranth date flavoured milk.

Parameter	ADFM
Total solid (%)	20.83±0.16
Fat (%)	2.77±0.15
Protein (%)	3.07±0.18
Carbohydrate (%)	14.15±0.17
Ash (%)	0.84±0.12
pH (at 25°C)	6.23±0.13
Viscosity (cP at 20°C)	40.53±1.09
Sediment (g/100 g)	4.87±0.18

combination(s) of different levels of factors *viz.* level of amaranth (% w/w of milk), level of date extract (% w/w of milk) and level of sugar (% w/w of milk) that would lead to the most acceptable product in terms of sensory characteristics. The goals for all sensory responses were set to be maximized. The predicted formulation for optimized ADFM from RSM analysis consisted of date extract (@ 5.1% w/w of milk), roasted amaranth flour @ 1.6% w/w of milk) and sugar (6.0% w/w of milk). The predicted sensory scores of ADFM are depicted in Table 6. The final product was manufactured employing the suggested formulation and the actual results obtained were compared with these predicted values of the criteria/responses selected for process optimization. The calculated t-values of for all the parameters are reported in Table 6. The calculated t-values being less than the table values, it is inferred that there was non-significant (P<0.05) difference between the predicted and actual values of responses.

Amaranth date flavoured milk prepared using the optimized solution of roasted amaranth flour @ 1.6% w/w of milk), date extract @ 5.1% w/w of milk and sugar (6.0% w/w of milk). The average values of the chemical composition of the developed ADFM is showed in Table 7. The developed product has 20.83% total solid, 2.77% fat, 3.07% protein, 14.15% carbohydrate and 0.84% ash. The pH, viscosity and sediment value of ADFM was 6.23, 40.53 cP and 4.87 g per 100 g.

Based on results obtained in this study, a method was standardized for development of a amaranth and date flavoured milk using date extract (@ 5.1% w/w of milk), roasted amaranth flour @ 1.6% w/w of milk), tri sodium citrate @ 0.15% and sugar (6.0% w/w of milk).

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