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The Pharma Innovation

ISSN (E): 2277- 7695
ISSN (P): 2349-8242
NAAS Rating: 5.03
TPI 2019; 8(10): 25-29

www.thepharmajournal.com
Received: 14-08-2019
Accepted: 18-09-2019

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Effect of level of strawberry powder on sensory qualities of low-fat spread

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Abstract
Fat spread means a product in the form of water-in-oil emulsion, of an aqueous phase and a fat phase of edible oils and fats excluding animal body fats. In the preparation of low-fat dairy spreads, various fat sources are used including cream, butter or ghee. The utilization of ghee in the low-fat spread (LFS) will boon to the Indian Dairy Industry, as in excess milk production most of the butter fat is stored in the form of ghee and it is a most logical approach. However ghee is more prone to the oxidation and therefore deterioration may occur. To control oxidation synthetic anti-oxidant are generally used. At the same time synthetic anti-oxidant have several health hazards. Therefore here an attempt was made to develop protocol for utilization of strawberry in LFS with increased shelf-life. It was found that the low fat spread prepared by the addition of the 4.0 per cent powder of strawberry had obtained maximum scored for all the sensory qualities among other three levels under study. In trial the results showed that the color and appearance, body and texture, flavour, spreadability and overall acceptability score of low-fat spread was recorded maximum for low-fat spread prepared by using strawberry powder at the rate 4.0 per cent. The validation of the prediction was done by actual observations recorded for sensory score. The optimized level had 7.84, 7.75, 8.10, 7.86 score for the color and appearance, body and texture, flavour, spreadability and overall acceptability respectively. Consumers as a whole liked the product 'moderately' to 'very much' with an average score of 7.70.

Keywords: Navel strawberry, strawberry low-fat spread, Sensory evaluation

Introduction
The fat in milk is primary to provide a source of energy to the new born baby. Dairy products, particularly higher-fat dairy products are considered significant sources of energy in the diet of vegetarian population too (Feeney *et al.* 2017) [3]. The milk fat products could be divided into several categories according to their fat contents, including anhydrous milk fat products, butter, cream and dairy fat spreads. Recently variety of dairy and non-dairy spreads is available on the customers door. These spreads may be to increase the content of unsaturated fatty acids for improvement of spreadability at low temperatures (Lee *et al.* 2018) [8]. Spreads are the products harmonizing with the idea of healthy nutrition. At the same time they have good taste and flavor as well as very good spreadability at refrigerator temperature and retain its stand up property even at high ambient temperature (Dostalova 2003) [2]. Spreads have low caloric content than butter and blends easily with other foods for convenience in cookery and serving. Both the dietary and convenience requirements of the consumer have been required by table spreads. Commercial table spreads now exists that contain fat level ranging from a high of 80 per cent all the way down to 0 per cent. Products resembling margarine containing less than 80 per cent fat are usually called spreads. As per regulations in some countries, only products containing less than 80 per cent but more than 40 per cent fat, 40-70 per cent fat, 62-80 per cent fat, or less than 75 per cent fat are labeled as spreads. Products with 60-80 per cent fat or with 41-60 per cent fat are 'reduced-fat' spreads and products containing less than 40 per cent are referred to as 'low-fat' spreads. The term 'very low-fat' spreads is used for spreads of 5-15 per cent fat and even less. The spreads with extremely low-fat content are sometime called 'Ultra low-fat' spreads. Low-fat spread, generally contain 30-50 per cent moisture, 30-50 per cent fat and 8-12 per cent solids-not-fat (Dostalova 2003) [2]. It can be manufactured from different types of fat (viz. butterfat, vegetable fat or other animal fat), protein (milk proteins e.g. skim milk, buttermilk, whey or their concentrated forms, sodium caseinate, calcium reduced skim milk powder, ultrafiltered protein concentrate, whey protein concentrate etc.)

and using additives like stabilizers, emulsifiers, plasticizers, emulsifying salts, vitamins, colorants and flavoring material. Considerable efforts have been made in India for development of fat spreads of dairy and non-dairy type using a variety of ingredients viz, butter, butter oil, cream, paneer, channa, cheese, vegetable fat and ghee (Patange 2006) [14].

The exploitation of ghee in the manufacture of low fat spread is the need of today's dairy industry due to its easy availability and better shelf life at ambient temperature. (Patange *et al.* 2015) utilized ghee in general as a source of fat in the manufacture of low-fat spread.

Ghee is a fat rich dairy product widely used in India since time immemorial. It has been an integral part of our culture. Ancient Sanskrit literature describes Ghee (Ghrita) as the food fit for Gods and commodity of enormous value. Nutritionally, ghee is a superior dairy product. Apart from a concentrated source of energy, it is also a good source of essential fatty acids, fat soluble vitamins like A, D, E & K and it also forms essential structural components of the cell membrane. With regards to digestibility, absorption and growth, it has been found that ghee lies in the completely digestible class of fat. It can therefore be an important dietary constituent for the patients having diseases of stomach, intestinal tract, liver, kidney, gall bladder (Toyabhai 2012) [16].

Despite of its numerous health benefits, over the past few years, ghee has received adverse publicity due to its cholesterol and saturated fatty acid contents. Both have been negatively implicated as perpetrators of arteriosclerosis (Sharma *et al.* 2010) hence hypertension. From the nutritionist's point of view, the removal of a whole food group from the diet, such as ghee simply to avoid cholesterol and saturated fatty acids is illogical and creates more difficulty for Indian people where ghee plays an important role in their diet (Parmar and Khamrui 2017) [13].

Consumption of phyto-chemical-rich foods such as fruits, vegetables are associated with a reduced risk of diseases mediated by oxidative stress and inflammation such as certain cancers, atherosclerosis and neurodegenerative diseases (Larsson *et al.* 2006) [7]. Berry fruits are reported to contain a wide variety of phenolics including hydroxybenzoic and hydroxycinnamic acid derivatives, anthocyanins, flavanols, condensed tannins (proanthocyanidins) and hydrolyzable tannins (Machiex *et al.* 1990). Strawberry is an important fruit of family Rosaceae.Occupies an important place among the small fruit plants and is grown throughout the world. Deep red in colour with unique shape, highly perishable fruit has a pleasant flavour. It is rich in vitamin C, sugar, organic acids anthocyanin, phosphorus, iron, other minerals, vitamins, etc. and its desirable flavour is characterized as fruity, sweet and tart. It is utilized for the production of purees, juice concentrate, juice, jams, preserves and rose red wine, (Sharma *et al.*2009) strawberries (*Fragaria*x *ananassa*) is one of the most popular fruit worldwide, with the high unique and desirable flavour. The main characteristics associated with the quality of ripe strawberries are their texture, and presence volatile compounds (Jiawei *et al.* 2019) strawberries are widely known for their potential health benefits due to their high fiber, potassium, vitamin C and folate contents. Strawberries are also a very good source of blood sugar-regulating dietary fibers (pectins, celluloses, etc.) and thyroid health-promoting iodine. Strawberry fruits are rich in sugars (mainly glucose and fructose, with smaller amounts of sucrose) and acids. Strawberry is good source vitamin C. It has been proved that vitamin C and phenolic compounds contribute to antioxidant capacity of fruits, as they act as oxygen radical scavengers and may exhibit beneficial health effects (Yildiz *et al.* 2014) Strawberries are rich in potassium (the most abundant mineral), calcium and magnesium. They are also a good source of folate, omega-3 fatty acids, vitamin B6, and vitamin K, as well as energy-promoting vitamins B2 and B5 (Milivojevic *et al.* 2010).

However, ripe strawberry is highly perishable mainly because of the smooth texture, high softening and respiration rate, as well as being proved to fungal attacks and off flavour development (Lara *et al.* 2004). Therefore it needs to utilize properly in different food items including low-fat spread.

Considering the nutritional, therapeutic and antioxidant properties of strawberry and use of ghee in low fat spread preparation, it is planned to use the strawberry in the preparation of ghee based low-fat spread

Materials and Methods

Fresh cow milk ghee was obtained from the local market of Kolhapur city. Spray-dried skimmed milk powder (SMP) was obtained from Kolhapur District Milk Producer Union Limited (Gokul), Kolhapur. Navel variety of strawberry fruit was procured from the local market of Kolhapur City. Carragenan- Type II Iota-carrageenan M/S (Hi Media) was used as stabilizer to make the emulsion stabilized. Sorbitol obtained from M/S Qualigens Fine Chemical, Mumbai and was usedas plasticizer to improve the spreadability of the low-fat spread. Polyoxyethylenesorbitanmonoleate (Tween-80) of (S.D Fine-chem. Ltd) emulsifier was used to make the emulsion strong. Iodized common salt was procured from the local market of Kolhapur city. Citric acid was purchased from M/S. Qualigens Fine chemical, Mumbai used for maintaining the pH of low fat spread.

Methodology

Preparation of strawberry powder

The Strawberry were procured from local market of Kolhapur and brought to Laboratory of Department of Animal Husbandry and Dairy Science, RCSM College of Agriculture, Kolhapur. The strawberry fruits were washed under running potable tap water. Then, fruits were blanched in boiling water for 3 to 5 minutes. After blanching the fruits were cut into four pieces and were kept for drying at 55 ºC for 18 hours (Olubunmi *et al.* 2013). The dried strawberry fruit pieces were grinded into powder using a kitchen mixer blender. The powder obtained was passed through 1mm stainless steel sieve. The sieved strawberry powder was sealed in plastic bags, at room temperature for further use.

Preparation of low-fat spread using cow milk ghee added with strawberry

Low-fat spread from cow milk ghee was prepared as per protocol developed by Patange (2006) [14] in planetary Mixer. The procedure involves separate preparation and tempering of fat and serum phases before blending and emulsifying them. For preparation of fat phase ghee was heated up to 50 °C and then added with the emulsifier. It was then heated (in a water-bath) to 70 °C before being rapidly cooled to 20 °C (rate of cooling, 12°C/min) with continuous agitation in a chilled water-bath (2.5°C ± 1 °C) and subsequently to 5 °C by quiescent holding in a refrigerator for an overnight period. The cooled fat phase was then tempered to the blending temperature of 25 °C ± 1 °C by holding in room temperature for 6 h before use. Skimmed milk powder as a source of

MSNF was dispersed in water together with soluble ingredients followed by mixing with an electric blender, preheating (55 °C), filtration (double- fold muslin cloth), pasteurization (72 °C for 15 - 20 sec), cooling in an ice water-bath to 20 °C, Before transferring in the aqueous phase in refrigerator it was added with strawberry in different forms as per the treatments. The aqueous phase was remained kept for overnight period of time at refrigerator temperature (5 °C). The selected variety, form and quantity of strawberry was added in the aqueous phase as per treatments. Finally, when required this aqueous phase was acidulated using a dilute citric acid to the desired pH 5.2 (30 min before blending) and warmed it to blending temperature.

The tempered fat phase was transferred to the bowl of planetary mixer and creaming was carried out using the flat beater attachment of the mixer for 30 sec at 'medium' speed. The serum phase was added in three equal installments. Blending was carried out after each addition of the serum phase using medium speed for 30 sec. The spreads was packed in 75 gm in plastic cups and closed with lids before being transferred to refrigerator (5 °C).

Optimization of level of strawberry in low fat spread

Strawberry to be added in LFS, the strawberry powder was added at following level. (The amount of powder was added on the basis of quantity of spread.)

SP_0 LFS without strawberry
SP_1 LFS with 2.0 % of strawberry
SP_2 LFS with 4.0 % of strawberry
SP_3 LFS with 6.0 % of strawberry

Samples were evaluated for sensory qualities and one best was selected.

Sensory evaluation

Sensory evaluation of strawberry added ghee based low-fat spread samples were carried out by a semi-trained panel of judges from the staff of the Division of Animal Husbandry and Dairy Science RCSM college of Agriculture, Kolhapur, by using 9-point Hedonic scale (Appendix-I) as described by (Hue, 1993).

Statistical analysis

The Data generated during the course of investigation were analyzed using completely randomized design (CRD) technique with five replications.

Results and Discussion

Effect of strawberry powder level on colour and appearance score of LFS

From the below Table and fig 1 it is clear that the colour and appearance score of low-fat spread was significantly ($P<0.05$) affected by the level of the strawberry powder. The maximum score was obtained to the low fat spread containing 6 per cent strawberry powder. It was found that as the level of strawberry powder increased the score of colour and appearance slightly increased. The panel judges' comments that the low fat spread containing 6 per cent has visual pinkish colour whereas sample containing low concentration 2 per cent of strawberry powder had faint pinkish colour. Sample containing 4 per cent of powder had slightly pink colour though the overall effect of level of strawberry powder was significant, however SP_1, SP_2 were at par with each other. Giampieri *et al*. (2011) reported that red colour in strawberry are produced by anthocyanin. Pandiyan *et al.* (2011) [12] reported that increase the level of mango in whey drink which lead to rise in the colour and appearance score of that beverage. Kavitkar *et al*. (2017) [5] studied on beetroot extract as a coloring agent on the sensory score of flavour milk and reported that with increasing the extract levels of the beetroot the colour and appearance score of the flavored milk was increased.

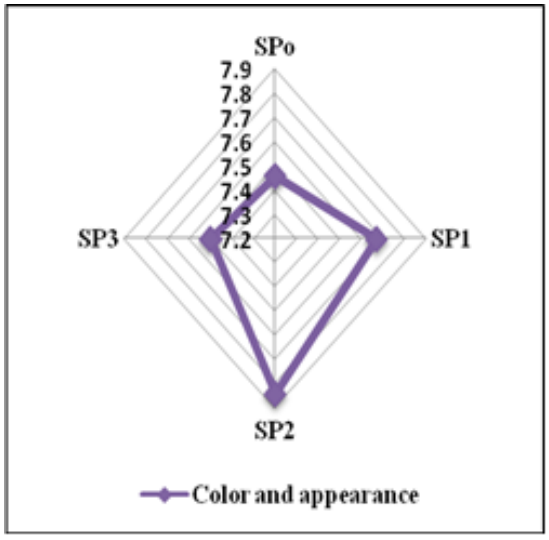

Fig 1: Effect of level of strawberry powder on colour and appearance of LFS

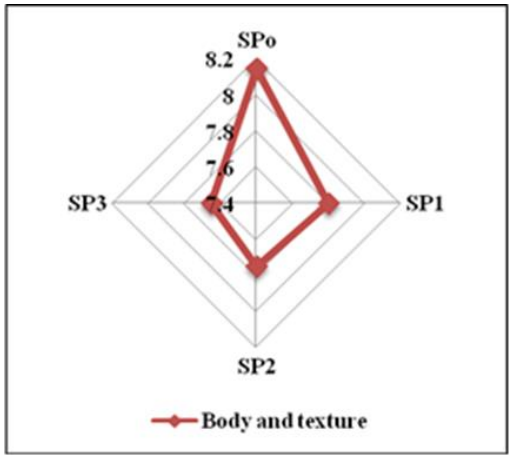

Fig 2: Effect of level of strawberry powder on body and texture LFS

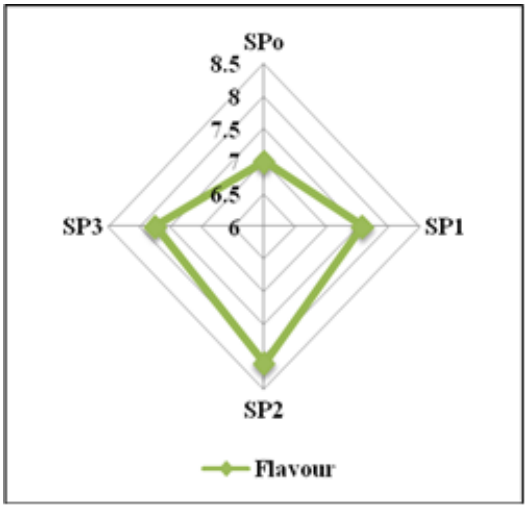

Fig 3: Effect of level of strawberry powder on flavour of LFS

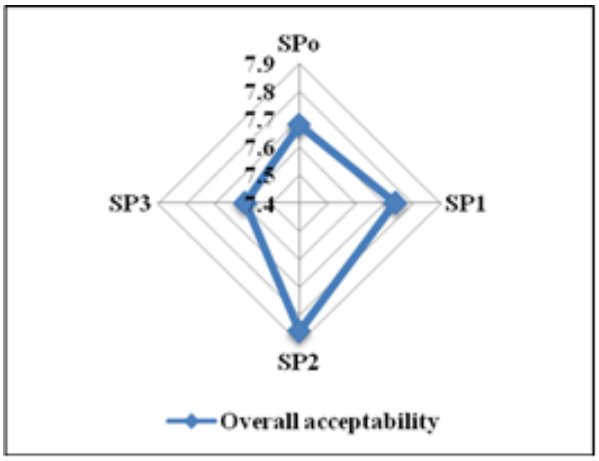

Fig 5: Effect of level of strawberry powder on overall acceptability of LFS

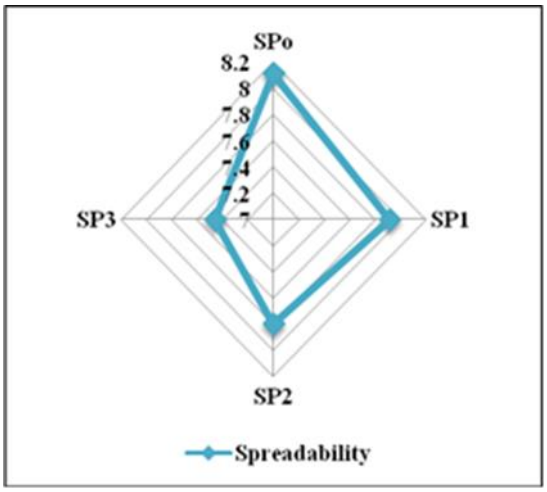

Fig 4: Effect of Level of Strawberry Powder on spreadability of LFS

Table 1: Effect of level of strawberry powder on sensory qualities (score*) of LFS

Treatment	Sensory attributes				
	Color and appearance	Body and texture	Flavour	Spreadability	Overall acceptability
SP_0	$7.46^{a}\pm0.07$	$8.15^{c}\pm0.05$	$7.00^{a}\pm0.03$	$8.12^{bc}\pm0.02$	$7.68^{a}\pm0.01$
SP_1	$7.67^{a}\pm0.05$	$7.80^{b}\pm0.05$	$7.58^{b}\pm0.04$	$7.92^{b}\pm0.05$	$7.74^{ab}\pm0.03$
SP_2	$7.84^{ab}\pm0.04$	$7.75^{b}\pm0.05$	$8.10^{bc}\pm0.05$	$7.80^{b}\pm0.05$	$7.86^{abc}\pm0.03$
SP_3	$7.50^{a}\pm0.05$	$7.65^{a}\pm0.05$	$7.75^{b}\pm0.05$	$7.46^{a}\pm0.04$	$7.59^{a}\pm0.02$
SEm	0.11	0.03	0.12	0.07	0.05
CD(p<0.05)	0.34	0.09	0.35	0.22	0.13

*Mean ± SE of five replications superscripts within column fallowed by same letter are non-significantly different at p<0.05.

Effect of strawberry powder level on body and texture score of LFS

From the Table and fig 2. It clearly revealed that the body and texture score of the product was more or less similar for all the sample. It was found that with increasing the level of the strawberry powder the body and texture score was slightly but significantly (p<0.05) decreased. As observed in 2, 4 and 6 per cent score was 7.80±0.05, 7.75±0.05, 7.65±0.05, respectively. It might be due to with increasing the strawberry powder there will be more the firmness in the body of product which results in decrease in the body and texture score. Similar findings were reported by Kharb (2007) [6] observed a decrease in body and texture of table spread with increase in the level of milk protein and dietary fiber content.

Effect of strawberry powder level on flavour score of LFS

As that of colour and appearance the flavour score was also significantly (P<0.05) affected by the level of the strawberry powder. The flavour score for low fat spread containing 0, 2, 4 and 6 percent were7.00±0.03, 7.58±0.04, 8.10±0.05, 7.75±0.05 respectively. It was also reported that the maximum (8.10±0.05) was recorded to sample containing 4 per cent strawberry powder and minimum score (7.00±0.05) was to the product prepared by without strawberry powder. Judges observed that the LFS with strawberry powder had slightly acidic and sweeting flavour. This might be eating qualities of strawberries with flavourable balance of sweetness and sourness ratio Nagai *et al.* 2018) [9] incorporation of fruit in spread was also reported by Ofosu *et al.* (2011) [10]

Effect of strawberry powder level on spreadability score of LFS

From the table and fig.4. It also noted that the spreadability score for low fat spread was also influenced by the level of strawberry powder. The score was decreased with increasing level of powder. The score was ranged from 8.12±0.02 to 7.46±0.04. That is the spreadability score is maximum in the SP_o (8.12±0.02) that is the low fat spread without strawberry powder. And minimum in the SP_3 (7.46±0.04) that is low fat spread containing 6 per cent strawberry powder. The decrease in score of spreadability may be because of rising in the TS content of spread as it is fact that the spread more with TS may reduce the spreadability.

Effect of strawberry powder level on overall acceptability score of LFS

The effect of level of strawberry powder on overall acceptability score was also depicted in Table. The data revealed that the overall acceptability score of LFS was significantly (P<0.05) affected by the level of the strawberry powder. The overall acceptability score for product SP_o, SP_1, SP_2, and SP_3were 7.68±0.01, 7.74±0.03, 7.86±0.03, 7.59±0.02 respectively. The maximum score for the low fat spread containing 4 per cent strawberry powder was 7.87.

The above findings are supported by Pakalwad *et al.* (2010) [11], they observed that the higher concentration of papaya pulp utilized decreases the score of overall acceptability of papaya milk shake. Pandiyan *et al* (2011) [12] also noticed that with increase in concentration of mango pulp in the whey drink increases the overall acceptability of the sweetened whey drink. Devi *et al.* (2018) [1] prepared with highly acceptable shrikhand by incorporating strawberry pulp @ 15%.

From the Table it was concluded that the strawberry powder rated score 7 and above for overall acceptability (like moderately) when it was added at 2, 4, 6 per cent hence the 4 per cent level was used and fixed for the further study of present investigation.

Conclusions

- Result of the present study indicated that on the basis of organoleptic evaluation use of blanched strawberry of navel variety at 4 per cent in the preparation of LFS was significantly superior over the other levels under study. The optimized level had 7.84, 7.75, 8.10, 7.86 score for the color and appearance, body and texture, flavour, spreadability and overall acceptability respectively.

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