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Effect of level of strawberry powder on physico-chemical properties 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. Fresh strawberry of navel variety was washed under running tap water fallowed by blanching, cutting in to pieces and subsequently dried in incubator at 55 °C for 16-18 hrs. These dry pieces crushed in electric grinder for 1 min., which was filtered through muslin cloth to get powder of strawberry. Navel variety Strawberry powder was added at the rate 2.0 (SP_1), 4.0(SP_2), 6.0(SP_3) percent and compared with control i.e. Low fat spread without strawberry powder (SP_0). Initially the form and level was optimized on the basis of sensory evaluation. The level of strawberry powder were optimized using CRD. In this study, the physic-chemical properties of samples of strawberry added low-fat spread with varying level strawberry powder were investigated. The results of the physic-chemical analysis indicate that as the amount of strawberry powder increases protein, ash increases whereas the total carbohydrate, total solid, oiling off decreases there is non-significant changes occurs in fat and wheeling off.

Keywords: Low-fat spread, strawberry, physico-chemical properties

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) [6]. 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) [12].

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) [5]. 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) [5]. 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) [17].

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) [18] 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) [22].

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) [19] 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).

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) [11]. Berry fruits are reported to contain a wide variety of phenolics including hydroxybenzoic and hydroxycinnamic acid derivatives, anthocyanins, flavonols, flavanols, condensed tannins (Proanthocyanidins) and hydrolyzable tannins (Machiex *et al.*1990) [13]. 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) [20] 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) [9] 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) [24] 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) [14].

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) [10]. 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 used as 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) [15]. 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) [17] 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

From above the treatments, best level was optimized.

Analytical work

Physico-chemical analysis

The product was analyzed for fat of the spread by Mojonnier method (Laboratory Manual, 1959), Total crude protein content of spread was determined By Kjeldhal's method given by Manefee and Overman (1940), The total carbohydrate estimated of spread was estimated by Lane-Eynon's method described in 1923, The total ash content was determined as per the method described in AOAC (1998), The procedure for the estimation of oiling off or free oil and wheying off in butter described by DeMan and Wood (1958) [4] was used with certain modification for the spread as suggested by Prajapati (1988).

Statistical analysis

The Data generated during the course of investigation were analyzed using completely randomized design (CRD) technique with five replications (Snedecor and Cochran, 1967).

Results

Effect of level of strawberry powder on physico-chemical qualities of LFS

On the physico-chemical quality of Low fat spread, as that of change in sensory quality of low fat spread the effects of strawberry powder was also shown. The strawberry powder added low fat spread prepared by using different levels of strawberry powder and it was analyzed for various physico chemical parameters viz. fat, protein, lactose, ash, total solid, wheying off and oiling off etc. these results are tabulated in table and discussed below.

Effect on fat

The fat content in strawberry added low fat spread is tabulated in Table 4.6 it was ranged from 40.34 to 40.00 per cent. The lowest per cent of fat recorded in low fat spread with 6% strawberry powder. The maximum percent fat obtained in the low fat spread without strawberry powder. It as there may be not presence of fat in the strawberry powder, the present trend was occurred in the result of the study are supported by the findings of Bajwa *et al.* (2003) [2]. They found that fat content decreases in strawberry added ice-cream.

Effect on protein

The protein content in strawberry added low fat spread was ranged from 5.34 to 5.83. the maximum protein content in strawberry powder added 6 per cent in the low fat spread whereas minimum protein content in the low fat spread without strawberry powder. The overall protein content in SP_0, SP_1, SP_2, and SP_3 produced LFS were 5.34±0.03, 5.45±0.05, 5.57±0.03, and 5.83±0.03 respectively. It is found that the variation in protein content were significantly higher in SP_3 may be because of protein content of strawberry powder up to 1.75 per cent Basu *et al*. (2007) and Wolkonson (2007). The result of this study is supported by the findings of Bajwa *et al.* (2003) [2]. They found that protein content increases were in strawberry added ice-cream from 4.00 to 4.30 per cent.

Effect on total carbohydrate

It is observed from Table that, the total carbohydrate content in low fat spread was ranged from 8.80 to 7.90 per cent. The highest amount of lactose (%) content was measured for low fat spread without strawberry powder (SP_O). Whereas lowest amount of lactose (%) content was measured in low fat spread with 6 percent strawberry powder (SP_3). The controversial finding was presented by Ghule *et al*. (2015) [8] is *lassi* were they mentioned that increased in level strawberry pulp the lactose content were also increased.

Effect on ash

The ash of strawberry powder added low fat spread was ranged from 2.84 to 3.11. The minimum ash was obtained for the low fat spread without strawberry powder (SP_O). The maximum ash was obtained low fat spread with 6 percent strawberry powder (SP_3). The rising in ash content with increase the strawberry powder may because of containing of ash in strawberry powder up to 3.17 (gm/50gm) as reported by Shell (2007) [21]. Compared fresh strawberry fruit contained less ash was reported by Giampieri *et al*. (2011) [7]. Amadou *et al*. (2018) reported that yoghurt ash content was reducing generally with increasing of ginger extract and it could be due to the low ash content of the ginger extract and dilution factor.

Effect on total solid

The total solid content in strawberry powder added low fat spread ranged from 57.38 to 57.44 per cent. The minimum per cent of total solid the low fat spread without strawberry powder (SP_o). The maximum total solid was obtained low fat spread with 6 percent strawberry powder (SP_3). Yousef *et al.* (2013) [25] showed that the addition of fruit pulp increased the total solid of frozen yoghurt therefore decreases in the moisture content of frozen yoghurt.

Effect on oiling off

The oiling off in strawberry powder added low fat spread was ranged from 3.58 to 3.74. The oiling off score for LFS SP_0, SP1, SP2, and SP_3, 3.77, 3.74, 3.69, and 3.58 respectively. The maximum oiling off occurs in the low-fat spread without strawberry powder (SP_0). The minimum oiling off was occurs in low fat spread with 6 percent strawberry powder (SP_3). Cortez *et al.* (2017) [3] reported that the strawberry contains anthocyanin pigment which had the good emulsion stabilizing property.

Effect on wheying off

The wheying off in strawberry powder added low fat spread was ranged from 7.38to 7.62. The wheying off score for LFS containing 0, 2, 4, and 6 per cent were 7.62, 7.59, 7.46, and 7.38 respectively. The maximum wheying off occurs in the low fat spread without strawberry powder (SP_0). The minimum wheying off was occurs in low fat spread with 6 percent strawberry powder (SP_3). Sharma *et al.* (2009) [20] reported that the strawberry contains various mineral which have ability to hold moisture as level of the powder increases the moisture content going to decreases hence the wheying off decreases.

Table 1: Effect of level of strawberry powder on physico-chemical qualities of low-fat spread

Treatment	Physico-chemical attributes						
	Fat (%)	Protein (%)	Total carbohydrate (%)	Ash (%)	Total solid (%)	Oiling off (%)	Wheying off (%)
SP_0	40.34±0.02	5.34^{a}±0.03	8.80^{d}±0.05	2.84^{a}±0.01	57.32^{d}±0.01	3.77^{c}±0.02	7.62±0.01
SP_1	40.22±0.03	5.45^{a}±0.05	8.48^{c}±0.02	2.96^{a}±0.04	56.75^{a}±0.09	3.74^{c}±0.04	7.47±0.02
SP_2	40.11±0.04	5.57^{a}±0.03	8.20^{b}±0.01	3.06^{ab}±0.02	56.94^{c}±0.02	3.69^{b}±0.06	7.59±0.02
SP_3	40.00±0.01	5.83^{ab}±0.03	7.90^{a}±0.08	3.11^{abc}±0.01	56.84^{b}±0.08	3.58^{a}±0.01	7.38±0.02
CD(p<0.0)	NS	0.25	0.044	0.155	0.03	0.04	NS

*Mean ± SE of five replications within column fallowed by same letter are non-significantly different at p<0.05 NS=Non significant

Fig 1: Effect of level of strawberry powder on fat

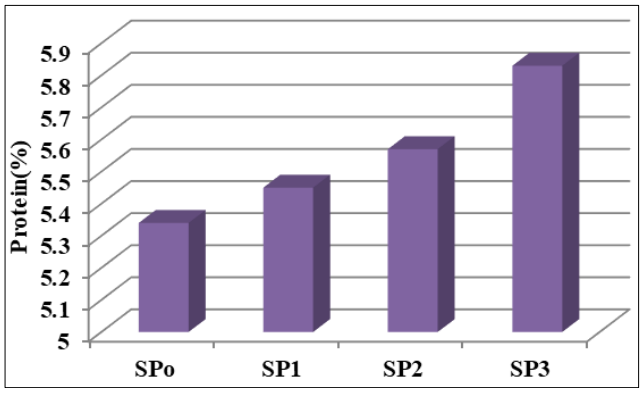

Fig 2: Effect of level of strawberry powder on protein

Fig 3: Effect of level of strawberry powder on total carbohydrates

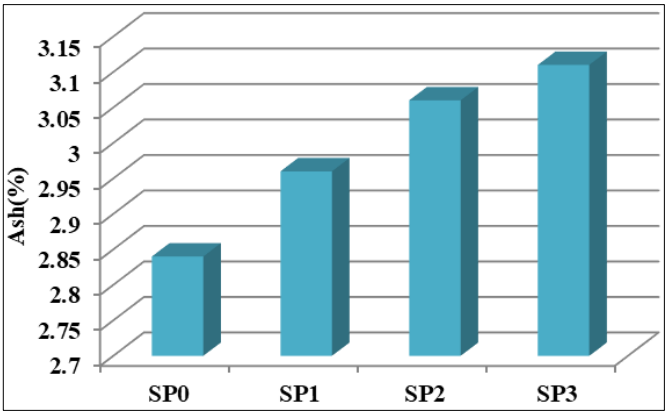

Fig 4: Effect of level of strawberry powder on ash

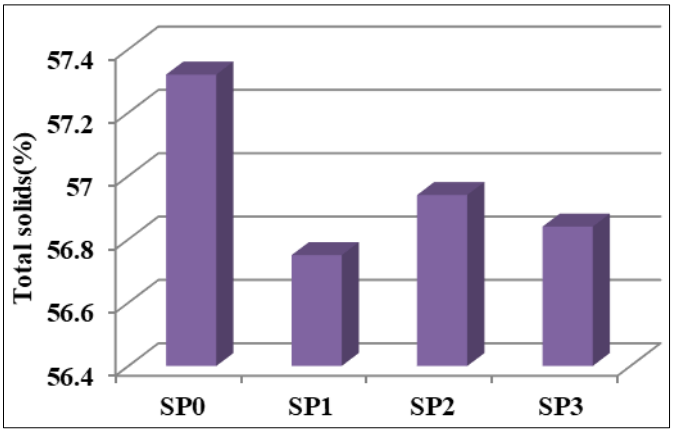

Fig 5: Effect of level of strawberry powder on total solid

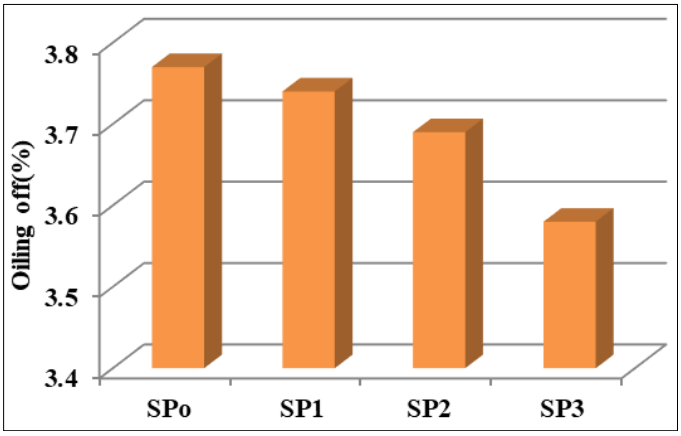

Fig 6: Effect of level of strawberry powder on oiling off

Fig 7: Effect of level of strawberry powder on wheying off

Conclusions

Results of the present study indicated that the amount of strawberry powder increases protein, ash increases due to presence of protein and ash in the strawberry powder whereas the total carbohydrate, total solid, oiling off decreases there is non-significant changes occurs in fat and wheying off because of the fat present in the strawberry powder is in very minute quantity.

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