Effect of Different Levels of Vegetable Oil for the Manufacture of Dahi from Skim Milk

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ABSTRACT : The experiment was conducted to investigate the feasibility of using vegetable oil and non-fat dry milk (powdered milk) with skim milk for the preparation of dahi. In this experiment, six different types of dahi were prepared from whole milk, skim milk and admixture of non-fat dry milk with different levels of vegetable oil. The prepared dahi samples were subjected to physical, chemical and microbiological analysis to evaluate their quality. It was observed that the addition of non-fat dry milk and vegetable oil with skim milk improve the physical qualities (smell and taste, body and consistency, color and texture) of prepared dahi samples. Addition of non-fat dry milk and vegetable oil also improve the total solids, fat and protein content of dahi samples. It is concluded that the addition of vegetable oil at a rate of 4 to 6% together with 5% non-fat dry milk gave the best result. ***(Asian-Aust. J. Anim. Sci. 2004. Vol 17, No. 7 : 1019-1025)***

Key Words : Dahi, Skim Milk, Non-fat Dry Milk, Powdered Milk, Vegetable Oil

INTRODUCTION

Dahi is a yogur-like fermented milk product (FAO, 1990) widely consumed all over India and the neighboring countries including the Himalayan region either plain, sugared or salted. The sweetened concentrated form of dahi in Bengal is known as mishti doi i.e. sweet dahi (Early, 1998). Although dahi and yogurt are more or less similar cultured and fermented dairy products, there are some differences between them. Yogurt is prepared by using the starter organism containing the thermophilic lactic acid streptococci and thermophilic lactobacilli in equal proportions whereas dahi is prepared by using mixed culture of *Streptococcus lactis, S. thermophillus, S. citrophilus, Lactobacillus bulgaricus, and L. plantarum etc.* (Mahanta, 1984). Different types of dahi are available such as sweet dahi, sour dahi and flavored dahi. Its demand is increasing day by day for its multipurpose health benefits such as improves intestinal health, which preventing constipation, diarrhoea and dysentry and also prevent gastrointestinal infections. It is also effective in lowering blood cholesterol, reduces coronary heart disease, breast and ovarian cancer. Immunity level also increased by dahi consumption (Kaic and Antonic, 1996)

Although it is very nutritious and popular food, the products available in the market lack quality and uniformity. Due to high milk price, manufacturers commonly sell the type of dahi that is not produced from whole milk. As a result consumers are not getting quality dahi and they are deprived of energy-enriched fermented milk product. In this regard, if the product can be produced from skim milk and milk fat can be replaced by vegetable fat then it will be a good idea to solve the above problem. As a result, price of the product will go down because skim milk is very cheap in the market and if milk fat is replaced by vegetable fat consumers will not be deprived from the energy source of the product. It can also be mentioned that some consumers dislike full-fat dahi or yogurt due to its high level of saturated fatty acids. In contrast, vegetable fat is less saturated and contains high level of unsaturated fatty acids. Unsaturated fatty acids have less chance of being deposited in the body due to their lower melting point. Therefore, vegetable fats are more healthy items to be used from the nutritional point of view. Vegetable fat such as soybean oil might be a good option to replace milk fat because soybean oil is widely used as cooking oil and available in the market throughout the country. Not only that, it has no bad odor and its price is also reasonable, side by side it can be stored for long time with maintaining its quality. As an alternative to whole milk, powdered milk is also used with skim milk for the manufacture of dahi (Richardson, 1985). In addition, powdered milk helps in maintaining the texture of the product that is one of the important factors for maintaining its commercial value.

Information on the feasibility of using vegetable fat in manufacturing fermented milk products, especially dahi, is scarce. The present research work was therefore undertaken to manufacture acceptable quality dahi from skim milk with the addition of powder milk and different levels of vegetable oil with the objectives to replace milk fat by vegetable fat and to recommend an acceptable level of vegetable oil for the manufacture of dahi.

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Table 1. Score card for judging dahi sample

Tests	Maximum points
Smell and taste	50
Smell	
Flavor	
Rancid	
Cooked	
Taste	
Acid	
Bitter	
Flat	
Sharp sour	
Moldy	
Body and consistency	30
Thick	
Thin	
Syneresis	
Gas	
Crack	
Color and texture	20
Color	
Light	
Deep	
Chuckled	
Greenish	
Texture	
Soft and lose coagulum	
Gassy coagulum	
Lumpy-gritty	

MATERIALS AND METHODS

Preparation of different types of dahi

Whole milk collected for the preparation of dahi was heated to boil consistently until it reduced to 20-25% of the volume of milk. At the boiling point of milk, sugar was added at the rate of 8% of the total volume of milk. During heating, milk was stirred thoroughly with the help of stirrer. After desired heating, milk pan was taken out from the heater and allowed to cool down to near 42°C and inoculated with 2% starter culture. After inoculation, warm milk of 42°C was poured into several clean plastic cups that were boiled previously for maintaining their hygienic quality and kept undisturbed at an incubation temperature of 37°C until coagulation. After complete coagulation (3.5-4 h), the dahi samples were taken out of the incubator and stored in a refrigerator at about 5°C for analytical purpose. All dahi used in this trial were prepared following the above way. Six different types of dahi were prepared and each treatment having four replication. These are described as follows.

A type dahi=prepared from whole milk.
B type dahi=prepared from skim milk.
C type dahi=prepared from skim milk+5% powdered milk
D type dahi =prepared from skim milk+5% powdered milk+2% vegetable oil
E type dahi=prepared from skim milk+5% powdered milk+4% vegetable oil
F type dahi=prepared from skim milk+5% powdered milk+6% vegetable oil

Powdered milk was added with the skim milk before heating of milk. Similarly, vegetable oil i.e. soybean oil was mixed to the skim milk during heating of skim milk. Before adding, soybean oil was heated for neutralizing its odd flavor.

Analysis of dahi samples

After preparation of all types of dahi different physical, chemical and microbiological tests were conducted to investigate the quality of dahi samples.

Physical test : A panel of six experienced judges assessed different types of organoleptic parameters such as smell and taste, color and texture, body and consistency separately and their score card were 50, 30 and 20 respectively. The parameters of smell and taste were flavor, rancid, cooked, acidity, bitter, flat, sharp sour and moldy. Body and consistency include thick, thin, syneresis, gas and crack. Color and texture parameters were light, deep, chuckled, greenish, soft and lose coagulum, gassy coagulum and lumpy-gritty. The score card used for judging the sample is given in Table 1. The grading scores were excellent (91-100%), good (81-90%), fair (71-80%) and poor (<70%).

Chemical analysis : To investigate the nutritional status of dahi following tests were conducted. These were acidity (%), pH, protein content (%), fat content (%) and ash content (%). Total solid and ash content of the different types of dahi were determined according to AOAC (1982). Fat percentage was determined by Rose Gottelib method by using ether extraction of fat according to AOAC (1982). Acidity was determined by titrating with N/10 sodium hydroxide solution using the procedure of Aggarwala and Sharma (1961). Crude protein was determined by Kjeldahal procedure (AOAC, 1982) and pH was measured with the help of pH meter-215 (Ciba Corning Diagnostics Ltd. Sudhury, Sufflolk, England Co. 106×D).

Microbiological examination : Different types of microbiological tests like, gram-positive cocci (%), gram-positive rods (%) and total bacterial count/ml sample were performed to know the microbiological status of the products. For determination of gram positive cocci and gram positive rods in dahi samples grams staining procedure was followed and for total viable count, standard plate count was done according to the method described in "Standard Methods for the Examination of Dairy Products". (Richardson, 1985).

Table 2. Physical characteristics (organoleptic evaluation) of different kinds of dahi (Mean±SD)

Physical parameters (score)	Whole milk dahi-A	SM dahi-B	SM+5%PM dahi-C	SM+5% PM+2% VO dahi- D	SM+5%PM +4% VO dahi- E	SM+5% PM+6% VO dahi- F	F value and level of significance
Smell and taste (50)	50±0.0	49±1.0	47±1.0	49±1.0	50±0.5	50±0.0	8.20 ***
Body and consistency (30)	27±2.7	27±1.0	30±0.0	29±0.0	30±0.0	30±0.0	4.88 **
Color and texture (20)	16±1.0	16±1.3	17±1.0	17±0.5	17±0.5	18±1.0	2.54 NS

SM=skim milk, PM=powdered milk, VO=vegetable oil (soybean oil). ***= $p<0.001$, **= $p<0.01$, NS= $p>0.05$.

Table 3. Chemical composition of different types of dahi (Mean±SD)

Chemical parameters	Whole milk dahi-A	SM Dahi-B	SM+5% PM dahi-C	SM+5% PM +2% VO dahi-D	SM+5% PM +4% VO dahi-E	SM+5% PM+6% VO dahi-F	F value and level of significance
Acidity (%)	0.60±0.01	0.60±0.01	0.61±0.01	0.67±0.02	0.66±0.01	0.65±0.00	22.87***
pH	4.00±0.00	4.00±0.00	4.20±0.00	4.10±0.00	4.10±0.00	4.10±0.00	NS
Total solid (%)	24.60±0.6	19.50±0.5	25.20±0.3	25.26±0.5	28.71±0.8	30.20±0.4	150.19***
Protein (%)	4.32±0.04	4.10±0.01	4.16±0.02	4.17±0.01	4.18±0.02	4.18±0.01	35.13***
Fat (%)	5.00±0.10	0.50±0.10	0.60±0.10	2.47±0.20	4.30±0.10	6.40±0.20	881.40***
Ash (%)	1.57±0.01	1.06±0.02	1.17±0.02	1.25±0.02	1.26±0.01	1.17±0.02	289.89***

SM=skim milk, PM=powdered milk, VO=vegetable oil (soybean oil). *** $p<0.001$, NS: $p<0.05$.

Data analysis

Data collected from different treatments were subjected to statistical analysis. Analysis of variance test (ANOVA) was done to find out the statistical difference between the treatments. In this experiment all data were analyzed by using one-way analysis of variance test (CRD) as per MSTAT statistical program.

RESULTS AND DISCUSSION

Physical properties

Smell and taste : There were significant differences ($p<0.001$) within the smell and taste scores of different types of dahi (Table 2). Smell and taste score of dahi prepared by skim milk decreased slightly compared to the dahi prepared by whole milk. This score decreased further in dahi C. This suggests that the addition of powdered milk to skim milk unlikely to improve smell and taste of dahi. However, addition of vegetable oil from 2 to 4% gradually and linearly improved smell and taste of dahi (dahi D and E) upto the level of smell and taste of dahi prepared by the whole milk. This result suggests that in a skim milk based dahi with 5% powdered milk, addition of vegetable oil from a range of 2 to 4% is necessary to improve smell and taste, beyond of which (e.g. 6% vegetable oil) might not affect smell and taste of dahi further.

Body and consistency : There was significant difference ($p<0.01$) within the body and consistency score of different types of dahi (Table 2). Body and consistency of dahi produced either by whole or skim milk was similar. However, body and consistency of dahi C reached to the plateau when 5% powder milk was added. Although there was a slight decrease in body and consistency of dahi D when 2% vegetable oil was added, not withstandingly this consistency was still higher than the dahi produced by whole or skim milk. In dahi E and F, body and consistency reached to the plateau again suggesting that the addition of 4% vegetable oil might be enough for a maximum consistency. This result also dictates that to get a maximum body and consistency in a skim milk based dahi one can use either 5% skim milk or 4-6% vegetable oil in the skim milk. Therefore, it is clear that the body and consistency score may be increased either by addition of powder milk or by a mixture of powder milk and vegetable oil. Dev (1992) reported that the addition of powder milk in dahi improves body and consistency, the result of which is in agreement with the present study.

Color and texture : There was no significant difference ($p>0.05$) within the color and texture of different types of dahi (Table 2). Color and texture produced either by whole milk and skim milk was similar. Although color and texture of dahi increased slightly with the addition of powdered milk (5%), addition of vegetable oil did not increase color and texture further until 6% vegetable oil was added. This result suggests that in a skim milk based dahi 5% powdered milk with 6% vegetable oil is necessary to improve color and texture score of dahi.

Chemical parameters

Acidity : There were significant differences ($p<0.001$) within the acidity of different types of dahi produced by whole milk, skim milk or skim milk with powdered milk (Table 3). Although acidity did not increase with the addition of powdered milk, acidity increased sharply with the addition of vegetable oil (2%) despite the fact that the acidity did not increase further with the increased level of oil (i.e. 4-6%). This observation is in line with Reddy et al. (1987) who reported that the variation in the titratable

Table 4. Comparison of microbiological condition of different types of dahi (Mean±SD)

Microbiological parameters	Whole milk dahi-A	SM dahi-B	SM+5% PM dahi-C	SM+5%PM+2% VO dahi-D	SM+5% PM+4% VO dahi- E	SM+5% PM+6% VO dahi-F	F value and level of significance
Gram-positive cocci (%)	73±1.0	75±2.0	71±1.0	73±1.0	71±1.0	71±1.0	5.33 **
Gram-positive-rods (%)	27±1.0	25±2.0	29±1.0	27±1.0	29±1.0	29±1.0	5.33 **

SM=skim milk, PM=powdered milk, VO=vegetable oil (soybean oil), ** $p<0.01$.

acidity could be attributed to the differences types of milk. The acidity of dahi used in this study matches neither the lower value of acidity (0.5) nor the higher value (1.1%) reported by Rangappa and Achaya (1971), although the acidity values (0.60 to 0.67) of dahi used in the present study were within the range reported by them.

pH : There was no difference ($p>0.05$) within the pH value of different types of dahi (Table 3) indicating that the powdered milk and vegetable oil have no effect on the pH of dahi. The result of present findings agrees with the work of Mustafa et al. (1991) who found that the pH of dahi made of whole milk was 4.25. Kosikowski (1966) suggested that the pH of normal dahi should be 4.4, which is almost similar to the values found in the present study.

Total solid : There was significant difference ($p<0.001$) between the total solids content of different types of dahi (Table 3). Lowest total solids found in dahi prepared from skim milk. However, total solids increased when powdered milk was added to the skim milk. Moreover, addition of vegetable oil with powdered milk to the skim milk based dahi gradually improved the total solid content of dahi (dahi D, E and F). Highest total solid content was obtained in the dahi F with the highest level of vegetable oil (6%). This suggests that the powdered milk and vegetable oil have significant effect to increase the total solid content of skim milk based dahi. Sarker et al. (1996) reported that the average total solid content of plain sweet dahi was 40.3. Ghosh and Rajorhia (1987) observed that total solids content of market dahi varied from 26.9 to 43.0% with an average value of 34.6%. Our data was lower than the findings of above workers but was much higher than the data reported by Desai et al. (1994) who found that the average total solids of plain sweet dahi was 22.0%. In fact, total solids content of dahi depend on different factors such as types of milk used and concentration of sugar (Ghosh and Rajorhia, 1987) as well as the heat treatment (Ray and Srinivajan, 1972). These factors in association with different ingredients used in different dahi might have been attributed to the differences in total solids of dahi used in the present study.

Protein : The protein content of dahi differ significantly ($p<0.001$, Table 3). Highest protein percentage was found in dahi A, which was prepared from whole milk whereas lowest protein was found in B type dahi, which was prepared from skim milk. Increased protein content of dahi C, D, E and F compared to the skim milk dahi may be due to the higher protein content of powder milk (Walstra et al., 1999). The protein content of dahi used in this study was in agreement with Desai et al. (1994) who reported that the protein percentage of fresh milk dahi were within the range of 3.7 to 4.3 percent.

Fat : There was significant difference ($p<0.001$) between the fat content of different types of dahi (Table 3). Lowest fat content (0.5%) was found in dahi, which was produced from skim milk. Addition of vegetable oil gradually increased the fat content of dahi (dahi D, E and F). It indicates that the addition of vegetable oil with the skim milk at the rate of 2-6% helps to increase the fat level of dahi. Fat content of dahi in the literature varied significantly. Ghosh and Rajorhia (1987) reported that the fat content of whole milk dahi varied from 4.3 to 8.8 with an average of 3.78%. Sarkar et al. (1992) on the other hand, found that the fat percentage of plain dahi ranged from 1.1 to 11.5 with an average of 5.14%. The fat content of dahi in the present study was within the reported range in the literature, although the highest value in the literature was much higher than the highest fat content of dahi used in the present study. Similarly, the lowest fat content of dahi in this study was too low than the fat content of dahi used in the literature probably due to the use of skim milk or powdered milk in dahi.

Ash : There was significant difference ($p<0.001$) between the ash content of different types of dahi samples (Table 3). Highest ash (1.6%) content was seen in case of dahi prepared from whole milk and lowest (1.1) was seen in case of dahi prepared from skim milk. Addition of powdered milk and vegetable oil increased the ash content only slightly. It indicates that the addition of powdered milk and vegetable oil unlikely to increase the ash content of skim milk based dahi. The ash content of dahi prepared from whole milk used in the present study agreed with the results of the ash content of whole milk dahi in the literature (Desai et al., 1994; Mustafa, 1997).

Microbiological parameters

Gram-positive cocci (%) : Gram-positive cocci of different dahi differed significantly ($p<0.01$; Table 4). Although gram positive cocci of skim milk based dahi (75%) was higher than the whole milk based dahi (73%), addition of powdered milk in the skim milk reduced the gram positive cocci irrespective of addition of vegetable oil. The Gram positive cocci of dahi found in this study was

Table 5. Comparison of total bacterial count per ml of dahi sample

Dahi sample	Total bacteria/ml sample		Average value±SD	F value and level of significance
	Original value ($\times 10^4$)	Log value		
Whole milk dahi-A	22	5.34	5.34±0.02	13.95 ***
SM dahi-B	21	5.32	5.32±0.04	
SM+5% PM dahi-C	23	5.36	5.36±0.02	
SM+5% PM+2% VO dahi-D	26	5.41	5.4±0.02	
SM+5% PM+4% VO dahi-E	27	5.43	5.43±0.02	
SM+5% PM+6%VO dahi-F	27	5.43	5.43±0.00	

SM=skim milk, PM=powdered milk, VO=vegetable oil (soybean oil). *** $p<0.001$.

Table 6. Correlation (r) between levels of vegetable oil (VO%) and chemical compostion of dahi and intra-correlation between chemical composition of dahi

	VO%	pH	Total solid	Protein	Fat	Ash
VO%	1					
pH	-0.77	1				
Total solid	0.95	-0.57	1			
Protein	0.94	-0.87	0.88	1		
Fat	1.00	-0.76	0.95	0.93	1	
Ash	0.03	-0.58	-0.12	0.34	0.00	1

similar to that reported by Monojit (1998). The Gram positive cocci generally found in dahi and culture are *Streptococcus thermophilus, S. lactis, S. fecalis and S. citrophilus* (Mohanta, 1984; Sarkar et al., 1992).

Gram-positive rods (%) : Gram-positive rods (%) of different kinds of dahi differ significantly ($p<0.01$) among different kinds of dahi (Table 4). Gram positive rods was lowest (25%) in skim milk based dahi. However, addition of powdered milk to the skim milk increased the Gram positive rods to the level of dahi based on whole milk (27%) or slightly more than that (29%) in dahi made of skim milk irrespective of addition of skim milk. The Gram positive rods of the dahi prepared from whole milk was similar to the results of Hasan (1970) who reported 26% Gram positive rods in dahi prepared from whole milk. Gram-positive rods usually found in dahi and its culture are *Lactobacillus bulgaricus* and *L. plantarum* (Mohanta, 1984).

Total viable count : The average total bacterial count/ml of different dahi were 22×10^4 (log 5.34±0.02), 21×10^4 (log 5.32±0.04), 23×10^4 (log 5.36±0.02), 26×10^4 (log 3.41± 0.02), 27×10^4 (log 5.43±0.02) and 27×10^4 (log 5.431±0.00) for A, B, C, D, E and F dahi samples respectively (Table 5). There were significant differences ($p<0.01$) among different types of dahi. Highest total viable count was recorded for E and F type dahi and lowest total viable count was recorded for B type dahi. However, Alam (1999) found three times higher total viable count/ml of dahi sample (75×10^4 (log 5.878±0.03) than the number in the present study. The differences in Gram positive cocci and rods described above as well as differences in total viable count might be due to the differences in ingredients particularly the vegetable oil used in the present study.

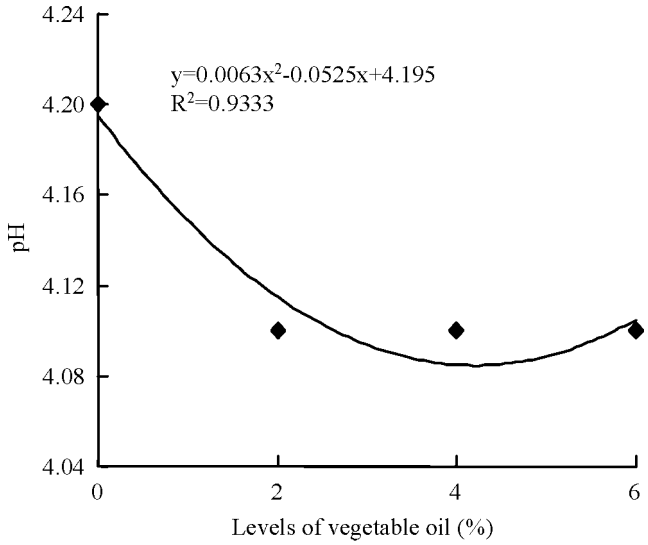

Figure 1. Relationship (R^2) between levels of vegetable oil (%) and pH of dahi.

Relationship

Relationship (r) between the level of vegetable oil and chemical properties of dahi and their intra-relationship are presented in Table 6. Relationship between the level of vegetable oil and chemical properties of dahi were high and positive except that of pH, which was negatively related to the vegetable oil, and no relationship existed between vegetable oil and ash (minerals). These relationship suggests that the addition of vegetable oil likely to increase the preservation quality of dahi and 2% vegetable oil is likely to be enough (Figure 1), but it will not improve the mineral content of dahi.

The relationship between vegetable oil and total solids or fat content of dahi suggests that for each unit increase in vegetable oil, the corresponding total solid and fat likely to increase at the rate of 0.92 (Figure 2, $R^2=0.90$) and 0.96 (Figure 3, $R^2=0.99$), respectively. This suggests that to increase total solid and fat content of dahi, it will be a good idea to add vegetable oil. However, the relationship suggests that the protein content of dahi cannot be increased beyond 4% vegetable oil (Figure 4; $Y=0.006 X^2+0.0071X+4.160$; $R^2=0.98$).

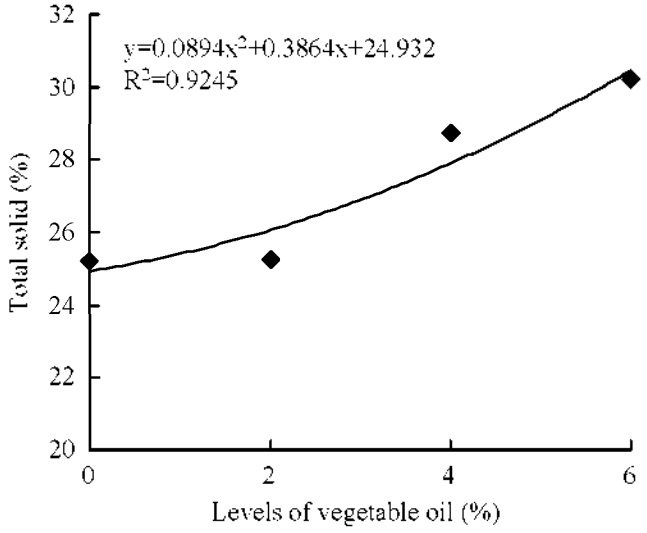

Figure 2. Relationship (R^2) between levels of vegetable oil (%) and total solid (%) of dahi.

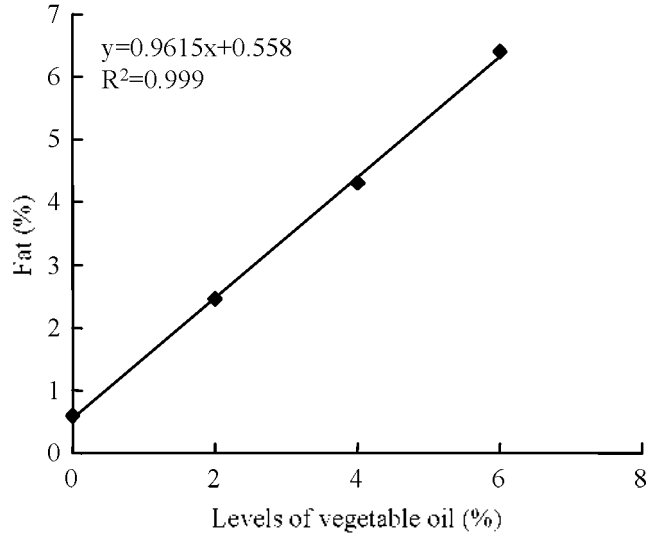

Figure 3. Relationship (R^2) between levels of vegetable oil (%) and fat (%) of dahi.

CONCLUSIONS

Judging from different parameters studied, it may be concluded that vegetable oil such as soybean oil could be used successfully to prepare dahi to replace milk fat and to improve quality of dahi. Addition of vegetable oil not only enriches the nutritive value of dahi, but also makes the product cheaper in comparison to the dahi produced form whole milk. Addition of non-fat dry milk and vegetable oil also improve the total solids, fat and protein content of dahi samples. It is concluded that addition of vegetable oil (soybean oil) at the rate of 2 to 6% together with 5% non-fat dry milk (powdered milk) could be used successfully and inexpensively improves quality of dahi.

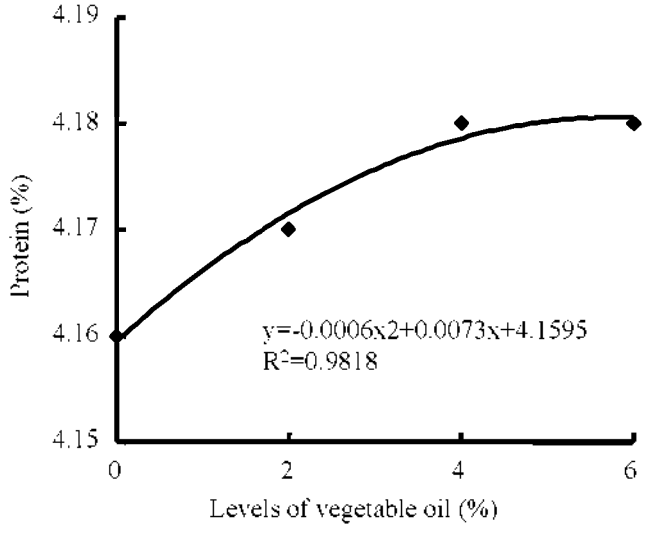

Figure 4. Relationship (R^2) between levels of vegetable oil (%) and protein (%) of dahi.

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