Standardization of Fat:SNF ratio of milk and addition of sprouted wheat *fada* (semolina) for the manufacture of *halvasan*

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Abstract Traditional Indian Dairy Products such as Halvasan are manufactured in India using an age old practice. For manufacture of such products industrially, a standard formulation is required. Halvasan is a region specific, very popular heat desiccated milk product but has not been studied scientifically. Fat and Solids-not-fat (SNF) plays an important role in physico-chemical, sensory, textural characteristics and also the shelf life of any milk sweet. Hence for process standardization of Halvasan manufacture, different levels of Fat:SNF ratios i.e. 0.44, 0.55, 0.66 and 0.77 of milk were studied so that an optimum level yielding best organoleptic characteristics in final product can be selected. The product was made from milk standardized to these ratios of Fat:SNF and the product was manufactured as per the method tentatively employed on the basis of characterization of market samples of the product in laboratory. Based on the sensory results obtained, a Fat:SNF ratio of 0.66 for the milk has been selected. In the similar way, for standardizing the rate of addition of *fada* (semolina); 30, 40, 50 and 60 g *fada* (semolina) per kg of milk were added and based on the sensory observations, the level of *fada* (semolina) addition @50 gm/kg of milk was adjudged the best for Halvasan manufacture and hence selected.

Keywords Fat:SNF ratio · Sprouted wheat *fada* (semolina) · *Halvasan* · Composition · Physico-chemical · Sensory · Texture

Introduction

Halvasan is traditionally manufactured in Khambhat/Cambay region which is an ancient sea port of Gujarat since more than 125 years. It is heat desiccated milk based sweet prepared from mixture of milk and sprouted wheat *fada* (pieces). *Halvasan* contains approximately 11.37 % milk fat, 9.61 % protein, 10.18 % lactose and 1.26 % ash, 24.15 % sucrose and 28.92 % other matter. The other matter includes the sprouted wheat *fada* solids which is the rich source of nutrients because of sprouting process. It is sweetened and after desiccation is richly coloured, flavoured and decorated using nutmeg, cardamom, pistachio and saffron. Thus, traditionally made sweet is rich source of nutrients derived from milk solids as well as high quality of germinated Bhalia Wheat solids. The main objective of the study is to standardize a process for the manufacture of *Halvasan*. In this endeavour, present study includes the Fat, SNF and wheat *fada* (semolina) standardization so as to get an optimum quality product. At present, there is no such standard process for the *Halvasan*, hence it is most desirable to have such standard process for the further study and also for its industrial application. From among various phases, the first one selected for the study is standardization of Fat: SNF ratio of milk used for the manufacture and the results obtained are used for selection of the optimum ratio to be employed for further study. In the similar way, the average proximate compositional values of market samples of *Halvasan* were experimented in preliminary trials for deciding the levels of *fada* (semolina) to be studied. Milk was standardized to have 0.66 fat:SNF ratio as decided in the first part of this study and thus, for standardizing the rate of addition of *fada* (semolina); 30, 40, 50 and 60 g *fada* (semolina) per kg of milk were added. The basic process used

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for manufacture of *Halvasan* using standardized milk to 0.66 Fat:SNF ratio with these four levels of *fada* (semolina) was as per Patel et al. 2010.

Materials and methods

To develop a standard formulation and the process, the study involved several phases, one of them is the Fat:SNF ratio of milk used for the manufacture and second is rate of addition of wheat solids i.e. *fada* (semolina). The *Halvasan* samples manufactured were analysed for their chemical composition, physico-chemical attributes, textural profile, sensory and microbial quality.

Materials used

Fresh whole milk, after procurement was standardized to different Fat:SNF ratio which were selected from the earlier study on characterization of market samples as per Patel et al. (2010). Good quality sprouted wheat *fada* (pieces) (semolina) and granular sugar was procured from the local market.

Process for *Halvasan* making

The basic process employed in preparation of *Halvasan* involved selection of milk considering its fat, SNF, acidity and alcohol test so that good quality milk can be taken for the manufacture. After filtration of the milk, in the first part of the study, the milk was standardized to desired Fat:SNF ratio. The proportion of Fat and SNF in most of the dairy products plays a pivotal role in deciding its physico-chemical and organoleptic characteristics as well as economics of the production. The Fat:SNF ratio of 0.44, 0.55, 0.66 and 0.77 were selected for the study based on the levels of Fat and SNF observed in market samples as well as on the basis of the preliminary trials conducted in our laboratory. This standardized milk was taken in a stainless steel kettle and rest of the process followed was as suggested by Patel et al. (2010). The mixture containing required quantity of Maida and Fada was added in the milk at lukewarm temperature. Any lumps formed were broken, the mixture heated gently to 90⁰ C and was maintained at the same temperature so as to allow the mixture to curdle and cook gradually. During this period, gentle stirring of the mixture was continued taking care to prevent any breakage of lumps formed as well as sticking and burning at the bottom. Also the coagulated lumps on surface of the mixture were sprayed with the separated liquid during stirring to avoid any surface drying. After Fada were cooked and attained a spongy texture like a soft junket, they were broken into small lumps by agitation and vigorous boiling. At this time, a calculated amount of crystal sugar was added and boiling was continued with

intermittent stirring and scrapping the sides and bottom of the Karai to avoid any sticking and burning. When a pat formation stage was reached, the mass becomes sticky. A small quantity of colour if required was added and the desiccated mass was removed from fire and was allowed to cool at room temperature by spreading it to the whole surface of the karai. After cooling, it was removed from the Karai and flavouring and colouring ingredients such as Nutmeg, Cardemom and Saffron, etc. were added as required. The required size of pieces~20–25 g in round flat shape were formed and garnished with chopped pieces of Cashew Nut, Pistachio, Pisti, Almond, etc. It was packed under hygienic conditions.

In the second part, for deciding the rate of addition of wheat solids, sprouted dry wheat solids (*fada*) (semolina) obtained from the nearby traditional Bhalia wheat growing region were added at different rates of 30, 40, 50 and 60 g *fada* (semolina) per kg of milk and the process of manufacture was followed in the similar way.

Based on the organoleptic characterization, the Fat:SNF ratio of milk and the rate of *fada* which resulted in the optimum quality product was selected.

Analysis

Compositional attributes

The moisture of the *Halvasan* samples was determined by standard procedure using Mojonnier Milk Tester Model-D (Laboratory Manual 1959). Fat extraction of *Halvasan* was determined as per the procedure described in Indian Standard: 2311 (1963). Total nitrogen/protein of *Halvasan* was determined by semi-microkjeldahl method (Indian Standard: 1479-Part-II 1961), using Kjel-plus digestion and distillation system (M/s.Pelican Instruments, Chennai). Reducing (lactose) and non-reducing (sucrose) were determined by the volumetric method specified for ice-cream in Indian Standard: 2802 (1964). Ash content of all the samples was determined by procedure described in Indian Standard: 1547 (1985). The content of other matter which comprised mostly the added wheat solids was derived by difference.

Physico-chemical quality attributes

The acidity of *Halvasan* was determined by method described in Indian Standard: 1166-(1968). The pH of *Halvasan* was measured using Systronic digital pH meter, Model 335 using the method described by Franklin and Sharpe (1963). The water activity (a_w) of *Halvasan* samples, tempered at 25 °C temperature, was measured using Rotronic Hygroskop Model: Hygrolab-3 (M/s. Rotronic ag, Switzerland). The soluble nitrogen content of *Halvasan*

sample was determined by the procedure outlined by Kosikowski (1982). The Free Fatty Acids (FFA) content was determined as per the procedure described by Thomas et al. (1954). The method presented by Keeney and Bassette (1959) for quantifying HMF by spectrophotometric (measured at 443 nm in Spectronic-20D, M/s. Milton Roy Co., USA) measurement of the 2-thio barbituric acid (TBA) reaction product was used with slight modification. The extent of oxidation of fat in *Halvasan* was measured in terms of TBA Value employing method of Strange et al. (1977) with slight modification.

Texture profile

Five samples of each experimental *Halvasan* were subjected to uniaxial compression to 70 % of the initial sample height, using a Food Texture Analyzer of Lloyd Instruments LRX Plus material testing machine, England; fitted with 0–500 kg load cell. The force-distance curve was obtained for a two-bite deformation cycle employing a Cross Head speed of 50 mm/min, Trigger 10 gf and 70 % Compression of the samples to determine various textural attributes of *Thabdi* held for 1 h at 23 ± 1 °C and 55 % RH.

Sensory evaluation

For the organoleptic evaluation of *Halvasan*, 8 judges were selected (on the basis of duo-trio test). The *Halvasan* samples were evaluated using a 100 point linear intensity rating scale. The score-card developed by Patel et al. (2010) was used for judging.

Microbiological analysis

All the *Halvasan* samples were analyzed for the Standard Plate Count (SPC), Coliform count and Yeast and Mold count (YMC) by the methods described in Indian Standards: 5550 (2005) with slight modification.

Statistical analysis

The mean values generated from the analyses of duplicate samples of *Halvasan*, obtained in five replications of each of the two stages were subjected to statistical analysis using Completely Randomized Design (CRD) as per Steel and Torrie (1980).

Results and discussion

Halvasan was manufactured as per the process suggested by Patel et al. (2010) employing whole milk standardized at different Fat: SNF ratio (viz., 0.44, 0.55, 0.66 and 0.77) and different rate of wheat *fada* (semolina) addition (viz., 30, 40, 50 and 60 g *fada* per kg of milk). The *Halvasan* thus

manufactured was evaluated for its proximate composition, physico-chemical properties, microbial quality, organoleptic characteristics and texture profile.

Influence on the average proximate compositional attributes

Standardization of Fat:SNF ratio

Standardization of Fat:SNF ratio is essential for production of uniform quality and economic aspects of manufacture of any dairy product. The mean values of compositional attributes of *Halvasan* influenced by changes in Fat: SNF ratio of milk are presented in Table 1. The values in the table show that due to progressive increase in Fat:SNF ratio of standardized milk from 0.44 to 0.77, the content of fat, sucrose, other matter, moisture, TS and yield of *Halvasan* manufactured were affected significantly ($P < 0.05$). The highest average compositional value for fat, sucrose, other matter, moisture, TS and yield content were 16.7 ± 0.18 , 24.1 ± 0.49 , 30.0 ± 0.09 , 15.3 ± 0.54 , 84.7 ± 0.54 and 48.0 ± 0.25 respectively. It can be observed from the data that on increasing the fat:SNF ratio of the milk taken for manufacture of *Halvasan*, the fat percentage increased linearly and significantly ($P < 0.05$) with all the treatments under study (i.e. 0.44, 0.55, 0.66 and 0.77 Fat:SNF ratios). The sucrose content varied significantly ($P < 0.05$) at 0.55 Fat: SNF ratios and above whereas other matter varied significantly ($P < 0.05$) at each of the ratios but in decreasing order. The moisture content and hence total solids content varied but significantly only at and after 0.66 Fat:SNF ratio. Similarly, yield of the product was affected significantly ($P < 0.05$) in increasing order.

Other compositional attributes viz. protein, lactose and ash contents of *Halvasan* though varied with the change in Fat: SNF ratio of standardized milk, they were statistically at par. This might be possible because no change was effected in the original SNF content of the milk standardized and the rate of addition of sugar, *fada* addition and final heating was kept constant.

Such study of manufacture of *Halvasan* by varying the Fat:SNF ratio of milk to be used has not been conducted and reported in the literature, and hence it is not possible to compare the data of this study. However, while studying the market quality of *Halvasan* from among the manufacturers in different cities, (Patel et al. 2010) observed the average values for moisture, fat and sucrose content ranging from 14.23 to 20.06, 6.31 to 10.17, 20.03 to 26.74 % respectively. This increase was the direct effect of increase in fat content in the product to increase the respective Fat: SNF ratio.

Addition of *fada* (semolina)

The mean values of compositional attributes of *Halvasan* influenced by changes in the rate of *fada* addition is presented

Table 1 Influence of standardization of Fat: SNF ratio of milk and rate of addition of *fada* on proximate composition of *Halvasan*

Compositional Attributes (%)	Fat:SNF ratio of milk				Addition of <i>Fada</i> (g/kg of milk)			
	0.44	0.55	0.66	0.77	30	40	50	60
Fat	11.5 ^a ±0.22	13.1 ^b ±0.08	15.2 ^c ±0.25	16.7 ^d ±0.18	10.3 ^{ab} ±0.04	11.1 ^a ±0.34	11.6 ^b ±0.07	11.6 ^b ±0.43
Protein	9.8 ^a ±0.15	9.6 ^a ±0.13	9.8 ^a ±0.17	9.4 ^a ±0.12	9.7 ^a ±0.07	10.1 ^b ±0.04	10.3 ^c ±0.01	10.4 ^d ±0.05
Lactose	9.8 ^a ±0.23	10.3 ^a ±0.08	9.7 ^a ±0.11	9.8 ^a ±0.29	9.8 ^a ±0.09	9.9 ^a ±0.05	9.9 ^a ±0.50	10.0 ^a ±0.06
Sucrose	22.3 ^a ±0.62	23.7 ^b ±0.33	23.7 ^b ±0.49	24.1 ^b ±0.49	24.4 ^a ±0.09	24.7 ^b ±0.05	24.7 ^b ±0.65	24.8 ^b ±1.41
Unidentified matter	30.0 ^d ±0.09	27.0 ^c ±0.06	26.3 ^b ±0.1	24.9 ^a ±0.05	29.2 ^c ±0.06	28.2 ^b ±0.09	27.4 ^a ±0.18	27.5 ^a ±0.20
Ash	1.2 ^a ±0.09	1.3 ^a ±0.01	1.3 ^a ±0.06	1.4 ^a ±0.05	1.3 ^b ±0.03	1.2 ^a ±0.03	1.2 ^a ±0.05	1.2 ^a ±0.01
Moisture	15.3 ^b ±0.54	15.0 ^b ±0.26	14.0 ^a ±0.17	13.7 ^a ±0.36	15.4 ^b ±0.07	14.8 ^a ±0.13	14.8 ^a ±0.22	14.5 ^a ±0.28
Yield % (w/w)	47.2 ^a ±0.19	47.6 ^b ±0.06	47.8 ^{bc} ±0.07	48.0 ^c ±0.25	47.1 ^a ±0.27	47.2 ^a ±0.32	48.1 ^b ±0.31	48.2 ^b ±0.14

Each observation is a mean ± SD of five replicate experiments ($n=5$)

Numbers in each labeled data superscripted with the same alphabet are not significantly different ($P<0.05$)

in Table 1. The tabulated values revealed that with progressive increase in rate of *fada* addition in the standardized milk, all the compositional attributes such as fat, protein, sucrose, other matters, ash, moisture and the yield of *Halvasan* except lactose content were affected significantly ($P<0.05$).

Fat content of samples of *Halvasan* having *fada* addition at the rate of 50 g and above which ranged from 10.3 ± 0.04 to 11.6 ± 0.43 % were observed statistically at par with each other ($P<0.05$). However, these values were significantly higher than the *Halvasan* made with addition of 30 g and 40 g *fada*. The protein content of all the samples of *Halvasan* manufactured with different rate of *fada* addition ranged from 9.7 ± 0.07 to 10.4 ± 0.05 % differed significantly ($P<0.05$) with each other. *Halvasan* having *fada* added more than 30 g significantly ($P<0.05$) differed in their sucrose content which ranged from 24.4 ± 0.09 to 24.8 ± 1.41 %. Ash content of samples of *Halvasan* having *fada* at the rate of 40 g, 50 g and 60 g were found statistically ($P<0.05$) at par with each other, but significantly lower than *Halvasan* having *fada* addition at the rate of 30 g. However, they ranged between 1.2 ± 0.01 to 1.3 ± 0.03 %. Though the other matter which comprised mostly wheat solids was affected significantly at 30 and 40 g addition levels as compared to other two levels, the trend was not uniform and ranged in between 27.4 ± 0.65 and 29.9 ± 0.06 %. The moisture content of *Halvasan* varied from 14.5 ± 0.28 to 15.4 ± 0.07 % differed significantly ($P<0.05$) at and after 40 g *fada* addition level. The yield of the product which varied significantly ($P<0.05$) at and after 50 g addition level was in the range of 47.1 ± 0.27 to 48.2 ± 0.14 %. The levels of *fada* added while manufacture of *Halvasan* did not have any influence on the lactose content.

There is no such study carried out using different rate of *fada* addition for *Halvasan* manufacture or similar traditional Indian dairy product. Hence, the result could not be compared.

Influence on the physico-chemical attributes

Standardization of Fat:SNF ratio

The average values of physico-chemical attributes of *Halvasan* made using standardized milk with different Fat: SNF ratio is presented in Table 2 which show that pH and FFA were affected significantly ($P<0.05$). The pH values decreased from 6.1 ± 0.042 to 5.8 ± 0.111 as the ratio of Fat:SNF was raised from 0.44 to 0.66 and on further rise in the ratio, the pH again increased. On the other hand, FFA values linearly increased from 0.74 ± 0.044 to 1.03 ± 0.035 which were significant ($P<0.05$) above 0.55 Fat:SNF ratio of milk. Other physico-chemical attributes such as acidity, soluble nitrogen, HMF, water activity and TBA values were not influenced significantly ($P<0.05$) by changes in Fat: SNF ratio of the milk used for the manufacture of *Halvasan*. The HMF value which is a measure of lactose-protein interaction was higher in sample having 0.77 Fat: SNF ratio as compared to all other samples, but the difference was non-significant ($P<0.05$). Free fatty acid (FFA) (as per cent oleic acid) is the measure of free fat liberated from the fat globules because of processing or any type of fat degradation occurring in the product. It may impart oily flavour and also may be responsible for the development of rancidity. FFA values consistently increased with the increase in Fat:SNF ratio. This might be due to the rise in level of fat content on increased Fat: SNF ratio.

When comparing the FFA and HMF content of *Halvasan* from different cities, (Patel et al. 2010) observed the average values for FFA and HMF of *Halvasan* ranging from 0.79 to 1.32 % and 304.36 to 1068.7 μ moles/100 g.

Addition of *fada* (semolina)

The average values of physico-chemical attributes of *Halvasan* affected by changes in levels of *fada* (semolina)

are presented in Table 2. The values revealed that except TBA values, all other values such as acidity, pH, soluble nitrogen, HMF, FFA and water activity of *Halvasan* were influenced significantly ($P<0.05$) by increase in levels of *fada* addition.

The acidity (ranging from 0.30 ± 0.012 to 0.37 ± 0.041 % lactic acidity) and pH (ranging from 5.6 ± 0.492 to 5.8 ± 0.048) of the final products are inversely related and with increase in *fada* levels, the values differed significantly ($P<0.05$) above the addition of 40 g *fada* while manufacture. Soluble N values though differed significantly ($P<0.05$), their trend was not uniform which ranged from 0.90 ± 0.025 to 1.22 ± 0.067 %. The HMF content (ranging from 425.2 ± 16.12 to 495.7 ± 42.7 μ moles/100 g) of *Halvasan* having *fada* addition at the rate of 30 g, 40 g and 50 g were statistically ($P<0.05$) at par with each other except for the product made with 60 g *fada*. The FFA content of *Halvasan* (ranging from 0.73 ± 0.018 to 0.80 ± 0.012 % Oleic Acid) made using *fada* at the rate of 40 g, 50 g and 60 g were significantly ($P<0.05$) at par with each other but differed and were higher than that obtained with the *fada* addition at the rate of 30 g. The water activity (ranging from 0.62 ± 0.031 to 0.69 ± 0.007) of *Halvasan* did not differ significantly ($P<0.05$) upto initial three levels (i.e. 30, 40 and 50 g) of *fada* addition. However, the later two levels i.e. 50 and 60 g *fada* addition were at par statistically ($P<0.05$). No scientific data has been published on the effects of different *fada* levels in *Halvasan* and hence could not be compared.

Influence of standardization of Fat/SNF ratio and addition of *fada* (semolina) on the microbial quality of *Halvasan*

The microbial count of the dairy product can affect the colour and appearance, flavour and body and texture of the product and thus influences its acceptability and hence shelf life. Therefore, all the samples of *Halvasan* were subjected to microbiological analysis for standard plate count (SPC), coliform count and yeast and mold count (YMC). The values shown in Table 3 are the original values. The coliform counts were absent in all the samples of *Halvasan* studied and hence not reported.

The standard plate count and yeast mould count of *Halvasan* made from standardized milk with different Fat:SNF ratio as well as addition of *fada* at different rates were not differing significantly ($P<0.05$) with each other as shown in Table 1. The non-significant changes in the microbial values might be because the fresh samples manufactured in the laboratory under controlled conditions were analyzed. The small numbers of counts of both the types of organisms might be attributed to the good hygienic condition during manufacture but some negligible post production contamination. All the samples of *Halvasan* differ non-significantly ($P<0.05$) with each other.

Patel et al. (2010) observed the average values of yeast and mold count as 84 cfu/g. and SPC count as 15,325 cfu/g in the market samples of *Halvasan* collected from different cities of Gujarat. However, the results of the present study are not comparable with them because these samples are prepared under laboratory conditions and were fresh when tested.

Influence on the sensory quality

Standardization of Fat/SNF ratio

The sensory attributes of *Halvasan* such as colour and appearance, body and texture, flavour as well as total scores as influenced by changes in Fat:SNF ratio are shown graphically in Fig. 1. All the values for sensory scores of *Halvasan* increased significantly ($P<0.05$) with increase in fat: SNF ratio. The values revealed that standardized milk having Fat:SNF ratio 0.66 obtained highest score in all sensory attributes, colour and appearance (13.3 ± 0.39), body and texture (32 ± 0.7), flavour (42.7 ± 1.58) and total score (93 ± 0.7) as compared to other samples having Fat:SNF ratio of 0.44, 0.55 and 0.77.

The values shows that samples of *Halvasan* having Fat:SNF ratio 0.77 and 0.66 were significantly ($P<0.05$) affected with each other in respect to colour and appearance. The *Halvasan* made using milk having Fat:SNF ratio 0.66 and 0.55 were found similar in body and texture and flavour score. The sample of *Halvasan* having Fat:SNF ratio 0.66 was found significantly ($P<0.05$) differing for total score of the final product. The most desirable characteristics of *Halvasan*, were found optimum in these samples. Also as shown in Table 1, milk having Fat:SNF ratio lower than 0.66 gave lower yield of the final product.

Samples of *Halvasan* having 0.66 Fat:SNF ratio had light brown colour, optimum Chewiness and sweet delicate flavour as compared to other treatment samples. The samples of *Halvasan* having 0.44 Fat:SNF ratio had dry surface, sticky body and texture and chalky flavour as compared to other samples. On the other hand, samples of *Halvasan* having 0.77 Fat:SNF ratio had slightly oily colour and appearance.

Addition of *fada* (semolina)

The sensory attributes of *Halvasan* such as colour and appearance, body and texture, flavour as well as total scores influenced by changes in levels of *fada* addition are presented in graphical way in Fig. 1.

The values presented show that scores of *Halvasan* for all the sensory attributes were significantly ($P<0.05$) affected by the changes in levels of *fada* addition. The average value of colour and appearance 13 ± 1.41 , body and texture 32.67 ± 0.78 , flavour 41 ± 1.84 as well as total score 91.7 ± 0.78 of *Halvasan* having 50 g of *fada* addition was found highest.

Table 2 Influence of standardization of Fat:SNF ratio of milk and rate of addition of *fada* on the Physico-chemical composition of *Halvasan*

Compositional Attributes (%)	Fat:SNF ratio of milk				Addition of <i>Fada</i> (g/kg of milk)			
	0.44	0.55	0.66	0.77	30	40	50	60
Acidity (% Lactic Acid)	0.32 ^a ±0.012	0.35 ^a ±0.013	0.33 ^a ±0.006	0.33 ^a ±0.016	0.30 ^a ±0.012	0.32 ^a ±0.018	0.36 ^b ±0.021	0.37 ^b ±0.041
pH	6.1 ^b ±0.042	6.1 ^b ±0.145	5.8 ^a ±0.111	5.9 ^{ab} ±0.037	5.8 ^c ±0.048	5.7 ^b ±0.028	5.7 ^a ±0.067	5.6 ^a ±0.492
Soluble Nitrogen, %	1.05 ^a ±0.11	0.87 ^a ±0.064	0.91 ^a ±0.014	0.92 ^a ±0.042	1.22 ^c ±0.067	0.95 ^a ±0.023	0.90 ^a ±0.025	1.11 ^b ±0.028
HMF (μ moles/100 g)	362 ^a ±36.4	371 ^a ±30.8	384 ^a ±47.8	392 ^a ±63.6	425.2 ^a ±16.1	429.1 ^{ab} ±40.0	448.3 ^{ab} ±66.8	495.7 ^b ±42.7
FFA (% Oleic Acid)	0.74 ^a ±0.044	0.75 ^a ±0.025	0.81 ^b ±0.077	1.03 ^c ±0.035	0.73 ^a ±0.018	0.78 ^b ±0.018	0.79 ^b ±0.049	0.80 ^b ±0.012
Water Activity(a _w)	0.73 ^a ±0.014	0.72 ^a ±0.007	0.7 ^a ±0.006	0.7 ^a ±0.012	0.69 ^b ±0.007	0.66 ^b ±0.007	0.64 ^{ab} ±0.05	0.62 ^a ±0.031
TBA (O.D. at 532 nm)	0.29 ^a ±0.038	0.37 ^a ±0.069	0.29 ^a ±0.047	0.29 ^a ±0.042	0.31 ^a ±0.067	0.37 ^a ±0.09	0.29 ^a ±0.025	0.35 ^a ±0.035

Each observation is a mean ± SD of five replicate experiments ($n=5$)

Numbers in each labeled data superscripted with the same alphabet are not significantly different ($P<0.05$)

Whereas values of these attributes were found lowest in *Halvasan* made using 60 g of *fada*.

As per the comments of judges after sensory evaluation, samples of *Halvasan* having 50 g *fada* gives optimum grain size, consistency, chewiness, compact body and shiny appearance. The samples of *Halvasan* having 60 g *fada* were found very sticky. On the other hand samples of *Halvasan* having 30 g *fada* were found very pasty and were lacking in grain size and brown colour.

Influence on the texture profile of *Halvasan*

Standardization of Fat/SNF ratio

The instrumental method of texture assessment aims at quantifying objectively the textural characteristics of food product to the maximum extent possible. The textural characteristics of *Halvasan* such as hardness, stiffness, adhesiveness, cohesiveness, springiness, gumminess, chewiness and fracture force are greatly influenced by its composition, type and quality of raw material like milk and wheat solids used as well as manufacturing parameters followed.

The average values of textural attributes of *Halvasan* affected by changes in Fat: SNF ratio of milk used for the manufacture is shown in Table 4. The values show that cohesiveness, springiness, Chewiness and stiffness of *Halvasan* manufactured

employing different ratios of Fat:SNF in milk were significantly ($P<0.05$) influenced. The cohesiveness (0.24 ± 0.001), springiness (8.3 ± 1.36 mm) and chewiness (37.2 ± 5.48 Nmm) values were highest in the samples with 0.66 Fat:SNF ratio, whereas stiffness (15.1 ± 4.56 N/mm) was the lowest and significantly ($P<0.05$) differing with all other samples.

The values of hardness, decreased from 76.4 ± 15.91 N to 20.1 ± 5.83 N when Fat:SNF ratio was increased from 0.44 to 0.66 but thereafter it increased on further increase in ratio. However, the variations were non-significant ($P<0.05$). Other textural attribute adhesiveness also varied in the similar way as hardness. The values of fracture force as well as gumminess though varied but non-significantly and the trend of variation was not regular.

Thus, change in Fat:SNF ratio had significant influence on cohesiveness, springiness, chewiness and stiffness of the texture attributes of final product and non significantly on hardness, adhesiveness, fracture force and gumminess..

Based on the above findings, the Fat: SNF ratio of 0.66 is suitable for manufacture of *Halvasan* and it was adjudged the best for *Halvasan* manufacture by judges.

Addition of *fada* (semolina)

The average values of texture attributes of *Halvasan* affected by changes in levels of *fada* addition is given in Table 4. The

Table 3 Influence of standardization of Fat:SNF ratio of milk and rate of addition of *Fada* on the microbial quality of *Halvasan*

Microbial Attribute	Fat:SNF ratio of milk				Addition of <i>Fada</i> (g/kg of milk)			
	0.44	0.55	0.66	0.77	30	40	50	60
SPC, (cfu/g)	17.5 ^a ±3.33	18.4 ^a ±6.77	26.3 ^a ±4.81	19.4 ^a ±8.13	23.2 ^a ±5.68	28.2 ^a ±12.63	27.6 ^a ±5.56	29.4 ^a ±12.77
Y & M, (cfu/g)	13.4 ^a ±3.99	13.3 ^a ±5.31	17.3 ^a ±3.28	19.7 ^a ±6.95	16.3 ^a ±5.4	19.3 ^a ±7.86	28.5 ^a ±12.41	13.8 ^a ±4.65

Each observation is a mean ± SD of five replicate experiments ($n=5$)

Numbers in each labeled data superscripted with the same alphabet are not significantly different ($P<0.05$)

Fig. 1 Influence of standardization of Fat:SNF ratio of milk and rate of addition of *Fada* on the sensory quality of *Halvasan*

Table 4 Influence of standardization of Fat:SNF ratio of milk and rate of addition of *fada* on the Physico-chemical composition of *Halvasan*

Textural Attribute	Fat:SNF ratio of milk				Addition of <i>Fada</i> (g/kg of milk)			
	0.44	0.55	0.66	0.77	30	40	50	60
Hardness, N	76.4 ^a ±15.91	56.6 ^a ±11.63	20.1 ^a ±5.83	36.6 ^a ±8.93	132.6 ^b ±25.95	81.0 ^a ±24.37	62.4 ^a ±14.67	67.5 ^a ±9.60
Cohesiveness	0.20 ^{ab} ±0.268	0.21 ^b ±0.059	0.24 ^c ±0.001	0.19 ^a ±0.144	0.07 ^a ±0.066	0.10 ^b ±0.184	0.13 ^c ±0.094	0.11 ^b ±0.081
Springiness, mm	3.9 ^a ±1.20	6.0 ^b ±2.29	8.3 ^{ac} ±1.36	5.0 ^{ab} ±3.14	1.8 ^a ±1.07	4.1 ^a ±1.95	4.8 ^a ±1.55	3.8 ^a ±1.61
Chewiness, N mm	34.6 ^b ±5.80	33.6 ^b ±8.84	37.2 ^b ±5.48	17.5 ^a ±364	23.8 ^a ±12.97	30.7 ^a ±16.20	36.9 ^b ±13.54	24.2 ^a ±10.79
Stiffness, N/mm	59.1 ^b ±12.92	53.5 ^b ±13.12	15.1 ^a ±4.56	42.7 ^b ±8.82	71.1 ^a ±17.59	67.3 ^a ±19.19	41.1 ^a ±11.66	30.9 ^a ±13.73
Adhesiveness, N mm	4.3 ^a ±3.88	3.5 ^a ±2.05	2.4 ^a ±0.09	2.6 ^a ±0.87	4.8 ^a ±2.24	11.9 ^{bc} ±6.75	9.4 ^b ±2.65	11.7 ^{bc} ±5.46
Fracture Force, N	26.9 ^a ±3.13	16.4 ^a ±2.56	17.4 ^a ±5.93	19.5 ^a ±3.20	81.3 ^b ±21.83	28.7 ^a ±13.53	18 ^a ±8.68	23.3 ^a ±12.14
Gumminess, N	4.4 ^a ±3.75	5.4 ^a ±1.86	4.3 ^a ±0.002	2.7 ^a ±1.30	3.5 ^a ±1.27	4.3 ^a ±2.00	4.4 ^a ±2.66	5.2 ^a ±2.55

Each observation is a mean ± SD of five replicate experiments ($n=5$)

Numbers in each labeled data superscripted with the same alphabet are not significantly different ($P<0.05$)

tabulated values show that due to progressive increase in levels of *fada* addition (30 g to 60 g) of standardized milk used for the manufacture of *Halvasan*, the mean values of its properties ranged for hardness (132.6 ± 25.95 – 67.5 ± 9.6 N), cohesiveness (0.07 ± 0.066 – 0.13 ± 0.094), chewiness (23.8 ± 12.97 – 36.9 ± 13.54 N mm), adhesiveness (4.8 ± 2.24 – 11.9 ± 6.75 N mm) and fracture force (18 ± 8.68 – 81.3 ± 21.83 N) of *Halvasan* manufactured and were affected significantly ($P < 0.05$).

Hardness values of *Halvasan* having 30 g *fada* addition were significantly ($P < 0.05$) higher than other samples of *Halvasan*. However, the *Halvasan* made using *fada* addition at the rate of 40 g, 50 g and 60 g were found similar in their hardness statistically. The *Halvasan* made with 50 g of *fada* addition yielded higher cohesiveness (0.13 ± 0.094) and chewiness (36.9 ± 13.54 Nmm) compared to *Halvasan* obtained with 30 g, 40 g and 60 g addition of *fada*. Adhesiveness of the samples having 30 g *fada* addition were found significantly ($P < 0.05$) lowest compared to other samples of *Halvasan*. Similarly *Halvasan* made with 30 g *fada* addition were found having highest fracture force as compared to other samples of *Halvasan*. However, adhesiveness and fracture force were found statistically at par ($P < 0.05$) in samples of *Halvasan* having levels of *fada* addition 40 g, 50 g and 60 g. With progressive increase in levels of *fada* addition (30 g to 60 g) of standardized milk used for the manufacture of *Halvasan*, the mean values of its properties viz., springiness (1.8 ± 1.07 – 4.8 ± 1.55 mm), stiffness (30.9 ± 13.73 – 71.1 ± 17.59 N/mm) and gumminess (3.5 ± 1.27 – 5.2 ± 2.55 N) were not affected significantly ($P < 0.05$).

Based on the above findings, the level of *fada* addition @50 g/kg of milk was adjudged the best for *Halvasan* manufacture.

Conclusion

Standardization of milk to Fat:SNF ratio of 0.66 and addition of sprouted wheat *fada* (semolina) @ 50 g/kg of milk for the manufacture of *Halvasan* significantly improves all the

sensory attributes of final product and yields a most acceptable product.

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