Physicochemical and Sensory Properties of Salad Creams Made from Yellow Corn Flour

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ABSTRACT

The study was carried out to evaluate the physicochemical, rheological and sensory properties of corn-based salad cream**.** Standard analytical methods were used in measuring the physicochemical composition and rheological property; while a 9-point Hedonic scale was used to evaluate the sensory characteristics of the salad cream. The values of pH varied between 4.5 and 5.5; while the control had a pH of 5.5. The formulated salad creams as well as the control sample had moisture content above 40 %; while protein and fat contents of the samples ranged from 0.88 % to 7.00 % and 1.70 % to 11.28 % respectively. The control had protein content of 8.75 % and fat content of 0.68 % in that order. Total available carbohydrate in the formulated samples ranged from 26.17 to 39.79 % and 27.57 % in the control sample. The titratable acidity for the samples ranged from 1.31 – 1.63 while the control was 1.55. The ash content values for sample ranged from 1.60 to 7.70 % while the control was 4.10 %. The values obtained for dry matter were in the range of 48.20 to 59.90 % and 49.80 % for samples and control respectively. Fiber in the samples and control sample were 2.15 to 8.75 % and 8.50 respectively. The formulated salad cream and the sample used as control have energy in the range of 170.7 to 234.2 kcal/g and 1151.4 kcal/g respectively. The value for viscosity of the various formulations of salad cream ranged from were 2.85 – 3.47 Pa.s. The control sample value was 20.50 Pa.s. Values for colour in the various formulated salad creams were 2.0 to 2.4 Hazen while that of the control was 2.6 Hazen. The mean scores of flavours, taste, aroma, texture, colour and overall acceptability of the salad cream samples prepared from yellow corn flour compared with a commercial salad cream shows flavour range of 6.4 to 6.6. Taste ranged from 6.6 to 6.8, aroma ranged from 6.6 to 7.2. Texture attribute ranged from 4.2 – 6.8 while the average score for colour range from 4.30 – 8.50 was observed in the samples. The sample F02 had the highest value (6.0) for overall acceptability while F03 had the least value of 5.8. Sample F02 was preferred by the Panellist to the control sample. This implies that comparable salad cream can successfully be produced from yellow corn flour.

Keywords: Salad cream, Sensory Evaluation, Formulation, Physicochemical properties, Rheological

INTRODUCTION

Food dressings are oil in water emulsions and are often used for seasoning food and enhancing its taste, colour and aroma. Salad cream is a creamy, yellow condiment based on an emulsion of about 25–50% of oil in water, it is prepared from ingredients such as distilled vinegar, vegetable oil, water, sugar, mustard, salt, egg yolks, modified corn flour / starch, xantham gum and guar gum as stabilizers and riboflavin for colouring [1]. Commercially, produced salad cream is usually made from distilled vinegar, vegetable oil, water, sugar, mustard, salt, egg yolks, modified corn flour/starch, xantham gum and guar gum as stabilisers and riboflavin for colouring [2].

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Starch has been the key carbohydrate storage produce in all plants with green parts containing chlorophyll. It is economically accessible and commonly used in many facets of life for the manufacture of industrial products. The distinctive characteristic of starch which enhances its use basically includes biocompatibility, biodegradability, gelation and modification according to its potential usage [3, 4, 5]. The presence of starch in salad dressing serves as a gelling agent, binding agent, thickening agent and a stabilizer. The modified food starch develops viscosity and protective colloid characteristics that help to prevent the breakdown of the blend during various processing steps [6].

Corn flour serves as effective thickener in salad cream preparation [7]. Starches are extracted from a number of different starchy raw materials, such as barley, maize, rice, sweet potato, and cassava. Sweet potato and cassava are two major starchy root and tuber crops used in many tropical countries [8]. Vegetable oils, the main ingredient in salad cream as well as mayonnaise, have an important function in an emulsion; they contribute to the taste, the appearance, the texture and the oxidative stability of the emulsion in a very specific way [9, 10].

Emulsifiers are substances that are soluble in both fat and water and enable fat to be uniformly dispersed in water as an emulsion. Foods that consist of such emulsions include butter, margarine, salad dressings, mayonnaise, and ice cream. Stabilizers maintain emulsions in a stable form. Emulsifying agents are also used in baking to aid the smooth incorporation of fat into the dough and to keep the crumb soft. Emulsifying agents used in foods include agar, albumin, alginates, casein, egg yolk, glycerol monostearate, gums, Irish moss and lecithin [11]. Emulsifiers are essential for emulsion formation and stabilization [12; 32]. The emulsion of salad dressing is largely stabilized by egg yolk [13]. Among the emulsifiers commonly used in the industry, whey proteins play an important role as effective emulsifiers in food products [14]. Caprine whey protein concentrates (WPC) were incorporated as emulsifiers in a salad dressing. The concentrates were manufactured by ultrafiltration-diafiltration with or without previousclarification by thermocalcic precipitation [15].

Salad cream has a sharper taste, and is less sweet often prepared for eating with mixture of raw vegetables. The inclusion of salad cream in vegetable salad improves the taste of the vegetables thus more vegetables could be consumed for more health benefits apart from the other nutritional benefits of the cream [16]. One of the conditions favouring stability of salad cream includes use of a thickening agent. Salad cream from corn and tigernut starch had desirable physicochemical and so an acceptable salad cream can be produced from tigernut and corn starch [17]. The aim of this work was to determine the physicochemical properties of three formulations of salad cream made from locally available raw material and to compare with those of commonly consumed commercial salad cream.

MATERIALS AND METHODS

Materials

The materials used include yellow corn flour, salt, sugar, water, soya bean oil, ethanoic acid as the acidifier, emulsifier (whole egg), antioxidant (ginger, garlic, onion). Yellow corn was bought, ground and sieved. Sugar, salt and bottles were procured from Abakpa Market, Enugu while the soya bean oil was purchased from Eke Awka market.

Method

Salad Cream Preparation

STEP I

The dry yellow corn flour (50.00 g) was dispersed in 200 mL of water. This mixture was cooked until paste was obtained and allowed to cool. The salt, sugar, flavourings, whole egg and ethanoic acid were blended with 100 mL of water, and the mixture was passed through a fine sieve and heated a little with stirring in a steam heated pan.

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STEP II

The corn flour paste was then added to the blend with stirring and the whole mixture was heated to a temperature of about 82 ^{o}C in a steam-heated pan with stirring. This was allowed to cool to 43 ^{o}C, and thereafter fresh vegetable oil was added in a fine stream with vigorous stirring maintained all through. The mixture was finally blended for about five minutes in an electric blender after which it was bottled and stored in a cool place before further studies.

Tables 1 to 3 shows the recipes for the different formulations of salad cream following step I and II [7].

Table 1: Recipe for formulation I (F01)

	Composition	
Materials/ingredients	**Weight (g)**	**Percentage (%)**
Soya bean oil	300.00	30.22
Corn flour	50.00	5.04
Sugar	170.00	17.13
Salt	15.00	1.51
Ethanoic acid	14.80	1.41
Whole egg	55.90	5.63
Water (mL)	387.70	39.06
Flavouring (ginger)	-	-
Total	992.70	100.00

Table 2: Recipe for formulation II (F02)

	Composition	
Materials/ingredients	**Weight (g)**	**Percentage (%)**
Soya bean oil	300.00	29.96
Corn flour	50.00	4.99
Sugar	170.00	16.78
Salt	15.00	1.50
Ethanoic acid	14.80	1.40
Whole egg	64.50	6.44
Water (mL)	387.70	38.72
Flavouring (garlic)	-	-
Total	1001.20	100.00

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Table 3: Recipe for formulation III (F03)

	Composition	
Materials/ingredients	**Weight (g)**	**Percentage (%)**
Soya bean oil	300.00	30.03
Corn flour	50.00	5.01
Sugar	170.00	17.02
Salt	15.00	1.50
Ethanoic acid	14.80	1.40
Whole egg	62.20	6.23
Water (mL)	387.70	38.81
Flavouring (Onions)	-	-
Total	998.90	100.00

Physicochemical Analysis

Determination of titratable acidity

1 g of blended portion of salad cream sample was weighed and put into 50 mL centrifuge tube respectively. 10 mL of distilled water was added to each tube to dissolve each respectively and then flitted. 1 mL aliquot of each solution was taken into another 50 mL centrifuge tube and 10mL of distilled water added to dilute the sample because it was highly coloured. 10 mL of the diluent was titrated against 0.1 N NaOH solution using phenolphthalein (2 drops) indicator percentage titratable acidity was calculated.

Determination of dry matter and moisture content

2 mL of each sample was measured into a previously weighted crucible, dried over water for some time. The crucible plus sample taken was then transferred into the oven set at 105 ^{o}C to dry to a constant weight for 24 hour. At the end of 24 hours, the crucible plus sample was removed from the oven and transfer to desiccators, cooled for ten minutes and weighed.

$$Dry\ matter\ (DM) = \frac{W_3 - W_\circ}{W_i - W_\circ}\ X\ \frac{100}{1} \quad (1)$$

$$\%\ \text{Moisture} = \frac{W_i - W_3}{W_i - W_\circ}\ X\ \frac{100}{1} \quad (2)$$

$$\%\ \text{Moisture Content} = 100 - \%\ \text{DM} \quad (3)$$

Where:

W_o = empty crucible

W_1 = weight of crucible plus Sample

W_3 = weight of crucible plus oven dried sample

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Determination of Ash

Procedure

2.0 g of sample was weighed into a porcelain crucible. This was transferred into the muffle furnace set at 550 °C and left for about 4 hours. About this time it had turned to white ash. The crucible and its content were cooled to about 100 °C in air, then room temperature in a desiccators and weighed [18].

$$\% \text{ Ash content} = \frac{\text{Weight of ash}}{\text{Original weight of sample}} \times \frac{100}{1} \qquad (4)$$

Determination of Crude Protein

The total nitrogen was determined by a modified kjedahl method and the result was multiplied by 6.25 to give crude protein.

Procedure

Digestion: The samples (2 g) were weighed into the flask. 0.05 g of mercuric oxide was equally weighed into the flask followed by 0.05 g of potassium tetraoxosulphate (VI) acid and 20 cm^3 of concentrated tetraoxosulphate (VI) acid was added. The mixture in the flask was digested using a heating mantle. Digestion was continued until the solution acquired clear colour. The digested sample was made up to 100 cm^3 in a 100 cm^3 volumetric flask.

Distillation: With the distillation apparatus in working order and having been steamed out for several minutes 10 cm^3 of saturated solution of boric acid was poured into the 5 cm^3 flask with addition of one to two drops of the mixed indicator. The flask containing indicator was attached to the receiving end of the condenser 10 cm^3 aliquot of digest was then transferred to the distillation apparatus with the external steam vent on the steam boiler remaining open. 10ml of 40 % alkaline thiosulphate mixture was also added into the distillation apparatus. The outside vent of the boiler was closed and steam distillation commenced. This was continued until about 25 cm^3 solution was received which give bluish colour in the boric acid indicator flask. The solution was titrated with 0.1 M of HCl acid to pink end point.

$$\% \text{ Nitrogen} = \frac{= \quad \text{V x 0.014 x M x D}}{W} \text{ X } \frac{100}{1} \qquad (5)$$

Where,

V = Volume of acid used

W = weight of sample

D = dilution factor [100/10 = 10]

Hence, % protein = Nitrogen x Nitrogen factor.

Nitrogen factor = 6.25

Crude Fat Determination

Procedure

The sun dried sample 10.0 g was weighed into fat free extraction thimble and plug lightly with cotton wool. The thimble was placed in the extractor and fitted up with reflux condenser and a 250 mL soxhlet flask which has been previously dried in the oven, cooled in the dessicator and weighed. The soxhlet flask is then filled to ¾ of its volume with petroleum ether (b.p 40 – 60 °C) and the soxhlet flask extractor plus condenser set was placed on the heater. The heater was put on for six hours with constant running water from the tap for

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condensation of ether vapour. The set was constantly watched for ether leaks and the heat sources were adjusted appropriately for the ether to boil gently. The ether was left to siphon over several times until it was short of siphoning. The thimble-containing sample was then removed and dried on a clock glass on the bench top. The extractor flask with condenser was replaced and the distillation continued until the flask was practically dried. The flask which now contains the fat or oil was detached, its exterior cleaned and dried to a constant weight in the oven [18]. If the initial weight of dry soxhlet flask was W_o and the final weight of oven dried flask + oil/fat was W_1, percentage fat/oil is obtained by the formula:

$$\text{Percentage fat/oil } \frac{W_i - W_2}{\text{Weight of sample taken}} X \frac{100}{1} \quad (6)$$

Crude fibre Procedure

The crude was determined as that fraction remaining after digestion with standard solution of sulphuric acid and sodium hydroxide under carefully controlled condition as specified by the association of offices at analytical chemicals.

Procedure

2.0 g of the oil free sample was placed in a beaker. 200 mL of hot 0.1275 M sulphuric acid was added. The contents were carefully transferred to a round bottomed flask which was later placed quickly under condenser and boiled gently for exactly 30 minutes using distilled water to maintain volume and to wash down particles adhering to the sides. The contents of the flask were then filtered through filter paper. The residue was washed with water and transferred back to the round-bottom flask after which 200 mL of hot 0.313 M NaOH was added. The flask was replaced under condenser and again boiled for 45minutes. It was filtered through filter paper. Finally, it was washed first with alcohol, dried overnight at 100 ^oC in an oven and weighed. The weighed sample was then placed in a crucible and was ashed in a muffle furnace at 500 ^oC for three hours. After switching off the furnace, this crucible with the ash was quickly transferred to desiccators to cool and was weighed.

$$\%\text{Crude fibre } \frac{(\text{Wt of crucible}) - (\text{Wt of crucible + ash})}{\text{Weight of sample taken}} \quad (7)$$

Carbohydrate Constant by difference

In the determination, the carbohydrate content of a sample was regarded as the nitrogen free extract and this was determined by adding up the percentage of moisture, Ash, protein, Fat and subtracting the sum from 100.

$$\% \text{ carbohydrate} = 100 - (\% \text{ Protein} + \% \text{ Ash} + \text{Moisture} + \% \text{ Fat}) \quad (8)$$

Calorific Value Determination

The Calorific value for the sample was determined by determining the carbohydrate content. Protein content, fat content, all multiplied with appropriate factors and adding up to get the energy content as shown in the relation below:

$$\text{Calorific Value} = (\% \text{ protein} \times 4) + (\% \text{ fat} \times 9) + (\% \text{ carbohydrate} \times 4) \quad (9)$$

pH Determination

The full range indicator paper was dipped into the sample whose pH was to be determined for a few seconds. The colour development was noted. The pH was read by comparing the colour developed with the colour scale (pH 1 – 14).

Sensory Evaluation

The sensory evaluation of the food products was carried out with the taste panel drawn from consumers of salad cream. The coded samples were presented to the panelists in a randomized manner such that the control sample (a regularly consumed commercial salad cream) was unidentified. A multiple comparison test was

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conducted to compare the organoleptic attributes such appearance (colour), aroma, taste (sourness), texture and flavour of the formulations with the reference sample. A 9 point Hedonic test (where 1 represented extremely better than F04 and 9 represented extremely inferior to F04) was used to determine the overall acceptability of the locally made salad creams.

The complete ratings are as shown [19]: 1 for extremely better than F04, 2 for much better than F04, 3 for moderately better than F04, 4 for Slightly better than F04, 5 for neither better than nor inferior to F04, 6 for slightly inferior to F04, 7 for moderately inferior to F04, 8 for much inferior, 9 for extremely inferior to F04; F04 is the control [33, 23].

RESULTS AND DISCUSSION

Proximate composition of salad cream produced from corn starch

The proximate composition of the salad creams (F01 –F03) formulated as well as that of the commercial one (Control) was carried out to determine their nutritional value and the result shown in Table 4.

Table 4: Proximate composition of salad cream formulations and control

Sample	Moisture content (%)	Dry matter (%)	Ash content (%)	Crude fibre (%)	Fats (%)	Protein Content (%)	Carbohydrate (%)	Titratable acidity	Calorific value (kcal/g)
F01	49.00	51.00	1.70	8.75	1.70	0.88	37.97	1.63	170.7
F02	40.10	59.90	7.70	5.15	5.72	1.54	39.79	1.31	216.8
F03	51.80	48.20	1.60	2.15	11.28	7.00	26.17	1.48	234.2
F04	50.20	49.80	4.10	8.50	0.68	8.75	27.57	1.55	151.4

F01= F02= F03= yellow corn-based salad cream, F04 = (Control: commercial salad cream)

Moisture

The result of the moisture content of the formulations and that of the commercial product ranged from 40.10 – 51.80 %. Low moisture content is an indication of better storability and shelf life [20, 7]. The high moisture content obtained in this study especially in F03 and F04 is as a result of large amount of water used in the preparation of the salad creams which implies they cannot be stored for longer time. The moisture content of any food indicates its level of water activity and can be used to measure its stability and susceptibility to microbial contamination [17]. It can also lead to hydrolytic rancidity, which can cause unpleasant flavour of the salad cream [34]. This means that they cannot be kept for a very long time. The trend of moisture in the three samples is F03>F01>F02. [21] reported moisture content of 57.84 and 64.88 % in cassava and potato starch-based salad cream respectively which are higher than the values obtained in this study. The moisture content in this study for F01 is about the same with that reported by [22] of 48.99 % and [2] who reported a range of 48.80-49.79 % for corn-cocoyam based salad cream while F02 is relatively lower.

Ash

For the formulated samples, the value ranged between 1.60 and 7.70 % with F02 and F03 having the highest and lowest value respectively while the control has ash content of 4.10 %. F02 has exceptionally high ash content, 7.70 % when compared to F01 and F03 whose values were 1.70 % and 1.60 % respectively. Ash content measures the amount of minerals present in food. This showed that F02 has high mineral content than other salad creams analysed, which implies that it has more nutrients and this is beneficial to the health of the

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consumer. The ash content obtained in this study is higher than those reported by [17] for salad cream produced from corn–tigernut starch blends, and [2; 20; 23] but similar to those reported by [22].

Fibre

The fibre content of the salad cream formulations ranged from 2.15 to 8.75 % while that of the control is 8.50 %. This indicates low digestibility when consumed. From the human nutrition perspective, fiber is the carbohydrate and lignin fractions of food and food ingredients that is indigestible by mammalian enzymes, although the carbohydrates may be fermentable in the large bowel [24, 25]. Millet-starch based salad cream showed no value for fibre according to the findings by [23] which is the same case with the findings of [2] who reported 0.00 % fibre in corn-cocoyam salad cream. In this study, however, a higher value for fibre was obtained indicating a low digestibility when consumed.

Protein

The protein content of these salad dressings ranged from 0.88 – 8.75%. This showed that the salad creams contains protein but cannot be relied on as a major source of protein since the values are low. Generally, the commercial salad cream contains higher percentage of protein compared to the formulations. However, the protein content of F03 is relatively close to that of the commercial salad cream (8.75 %). Results of this study show values which are higher than the ranges 0.23 to 0.35%, 0.37 to 1.61 and 0.17 to 0.31 % reported by [21], [22] and [20] respectively. The value reported by [26] for salad dressing is in agreement with those obtained in this study.

Fat

The values obtained for fat in the various samples of salad cream formulated ranged from 1.70 to 11.28 % with F03 having the highest percentage fat while that of the control was 0.68 %, which is the least value for fat. [21] reported a fat content of 25.17 to 28.15 % in cassava and potato starch based salad cream, while [2] reported a fat content of 27.04 to 29.68 % in corn-cocoyam starch salad cream all of which are higher than what was obtained in this study. Hence, the salad creams produced in this study can be recommended for consumers who are keeping watch at their fat consumption. Researches [27, 28] show that consuming raw vegetables with some source of fat helps with nutrient absorption, which is especially true with fat-soluble vitamins (vitamins that need fat in order to get absorbed into the body).

Calorie

The calorific value ranged from 151.40 – 234.2 kgcal/g for all the formulations which are higher than the value (151.1 kcal/g) of the commercial salad cream, which indicated that they contain reasonable amount of energy and would give energy when consumed.

Rheological Properties, Colour and pH of Salad Creams

The salad creams were analysed for rheological properties, Colour and pH, which were shown in Table 5.

Table 5: Rheological Properties, Colours and pH of Salad Creams

	Samples			
Parameters	F01	F02	F03	F04
pH	5.00	5.50	4.50	5.50
Colour (Hazen)	2.20	2.00	2.40	2.60
Viscosity (Pa.s)	3.47	2.85	3.15	20.50

F01= F02= F03= Corn-base salad cream, F04 = (Control: commercial salad cream)

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pH

Table 5 shows that the pH values obtained for the three salad cream formulations ranged from 4.50 to 5.50 with F03 and (F02=F04) having the lowest values respectively. pH is an important factor affecting growth of micro-organisms in food because it affects microbial enzyme activity and stability of cellular macromolecules. In addition, pH affects the sensory properties of many foodstuffs; it is a clue to the keeping quality of food products [29]. This applies not only to taste, but also to consistency of food. Spoilage of salad cream is a problem for the food industry [23]. Although some spoilage can be attributed to species of Bacillus and Lactobacillus, the primary spoilage organisms are species of Zygosaccharomyces, especially Z. bailii [6]. The pH value of F02 is exactly the same as that of the commercial salad cream. This acidic condition might destroy or inhibit the growth of micro-organisms during the shelf life periods, which would ensure the safety for consumption when kept at room temperature for about six months. The values obtained in this study for pH are slighly higher than 3.07 – 3.23, 3.07 – 3.62 and 3.57 – 3.77 obtained by [22, 17, 23] for cassava starch salad cream, corn-tiger nut salad cream, and millet starch based salad cream.

Colour

The results shows that there is no significant difference between the colour of the various formulations and that of the commercial product. The lower value of the formulations was an indication of the salad cream tending towards white colouration more than the commercial product. Colour is one of the most important quality attributes of salad cream because consumers' choices of which brand of salad cream to select from the market are influenced by this. The yellowish colour of salad cream is primarily provided by egg yolk carotenoids [30], and also by the yellow corn flour used in this study.

Viscosity

Table 5 shows the apparent viscosity of freshly prepared yellow corn flour salad cream. Viscosity of the salad cream ranged between 2.85 and 20.50 Pa.s with F04 having the highest, while F02 had the lowest value. The highest viscosity was observed in the commercial product. This showed that the salad creams made from locally available raw materials flowed more than the commercial product. This could be due to the modified corn flour used in its preparation.

Sensory Evaluation

Table 6 shows the result of sensory evaluation of the salad cream formulations: F01, F02 and F03

Table 6: Mean scores of sensory evaluation of the salad cream formulations

Samples	Flavour	Taste	Aroma	Texture	Colour	Overall Acceptance
F01	6.6	6.8	7.2	4.6	4.5	5.9
F02	6.4	6.8	6.8	6.8	5.0	6.0
F03	6.6	6.6	6.6	4.2	5.0	5.8

Consumer quality is a major factor for selecting a product and among the main characteristics related to quality are texture, taste, and surface color of foods [31, 17]. Table 6 shows the mean scores of flavours, taste, aroma, texture, colour and overall acceptability of the salad cream samples prepared from corn flour compared with a commercial salad cream. The results depict a flavour range of 6.4 to 6.6. Taste ranged from 6.6 to 6.8, aroma ranged from 6.6 to 7.2. Texture attribute ranged from 4.2 – 6.8 while the average score range of 4.30 – 8.50 for colour was observed in the samples. Based on flavour, F02 is most preferred while F01 and F03 ranked the same. Taste, aroma and texture attributes show that F03 was most preferred as F01 and F02 ranked the same in terms of taste. The aroma of F02 was preferred to that of F01 while the texture of F01 was preferred over that of F02 by the panellists. The colour of F01 was considered better that those of F02 and F03, which were rated equal (5.0) as indicated in Table 6.

The sample, F03, had the highest value (6.0) for overall acceptability while F03 had the least value of 5.8. The overall acceptance shows that sample F03 was the best of the three salad creams produced followed by F01 and then F02. Arranging the samples in decreasing order of preference gave: F03>F01>F02. Sample F02 was slightly inferior to the commercial salad cream while F01 and F03 were neither better than nor inferior to the commercial salad cream.

CONCLUSION

This study has shown that salad creams formulations with nutritional quality comparable to those of the commercial imported products can be prepared from locally available raw materials. It is clear from the results of sensory evaluation that acceptable salad cream could be obtained from these raw materials.

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