Kasetsart J. (Nat. Sci.) 34 : 500 - 509 (2000)

Oatrim-5 as Fat Substitute in Low Calorie Salad Cream : Nutritional and Microbiological Qualities

Nednapis Vatanasuchart and Siriporn Stonsaovapak

ABSTRACT

This research was attempted to modify low calorie salad cream substituted with 12 percent Oatrim-5 gel for soybean oil and to ensure safety for consumption of the salad cream. Three levels of oatrim-5 gel replacement at 50, 70 and 90 percent compared to control of salad cream were evaluated by descriptive and preference tests. The results demonstrated that the highest intensity of characteristics such as aroma, sourness, viscosity and flavor belonged to the control sample and the intensity became lower when the Oatrim-5 was substituted more, except color and smoothness. The preference toward characteristics except viscosity of the salad cream substituted with 50 percent Oatrim-5 were not significantly different from the sample with 70 percent substitution, and the 90 percent substituted sample seemed to be unacceptable to panelists. Addition of xanthan gum as thickening agent at 0.3-0.5 percent showed an improvement of stability, which could prevent breakage of the emulsions. When viscosity of the 70 percent level was measured, the sample with addition of 0.5 percent xanthan gum was more viscous than the others, reaching a value at 3070 cp. close to the control at 3740 cp. Moreover, analysis of proximate composition of the control compared to all substituted samples indicated a remarkable reduction in fat and energy content, which were 59.39, 29.81, 18.71 and 7.24 gram; as well as 595.21, 341.00, 242.00 and 144.00 kcal, respectively. In contrast, soluble fiber showed some increase at the higher oatrim-5 substitution. For safety test during shelf-life storage of 3 and 6 months, total viable count, molds, coliforms and aciduric spoilage bacteria were not detected in all the samples kept at both room temperature and at 4°c. Lastly, little change of acidity of the 90 percent substituted salad cream was observed, but still remained below 4.1.

Key words: Oatrim-5, nutritive values, shelf life, salad cream

INTRODUCTION

Salad cream served with fresh vegetables and some cooked meats have been familiar to Thai people for quite a long time and there has recently increased in using broader varieties of foods in salads including representative foods from the five basic food groups. Since they provide more nutritious dish with combination of vegetables, fruits, peas, beans, some cooked meats and source of carbohydrate such as macaroni or cereals; the salads become more favorite to most of the people concerning of their health. Despite that salad cream is an excellent source of fat content and also concentrated source of calorie, sometimes the consumers lack of awareness in an excess intake of

Institute of Food Research and Product Development, Kasetsart University, Bangkok 10900, Thailand.

the fat. According to Thai Industrial Standard No.1402-2540, definitions, composition and needed qualification of salad cream were established. Fat content was referred for differentiation of mayonnaise from salad cream or salad dressing. Mayonnaise must contain fat not less than 65 percent by weight, whereas salad cream must contain fat not less than 30 percent.

As we known from scientific evidences, the high consumption of fat can cause an accumulation of fat on blood vessels, leading to atherosclerosis, hypertriglyceridemia, hypercholesterolemia, hypertension and heart diseases (U.S. FDA, 1998). In eliminating or reducing dietary fat intake, replacement of fat with fat substitute must be employed for modification of low fat salad cream. In the U.S., characteristics of salad dressings and efforts to development of low calorie varieties were considered for several aspects including typical elements, appropriate fat replacers, acidification, use of emulsifiers and stabilizers as well as flavor enhancement (Bannar, 1997).

Oatrim-5 is a superior fat substitute derived from oats, which was invented and patented by USDA at the National Center for Agricultural Research. The process involved the α-amylase conversion of starch in oat flour or bran to amylodextrins. The product of β-glucan soluble fiber and amylodextrins was referred to as oat β-glucan- amylodextrins or Oatrim producing an excellent fatty textural material. It can be converted to a shorting like gel by heating and cooling a 25 percent dispersion. The Oatrim-5 is the only carbohydrate-type fat substitute that contains the unique combination of β-glucan and low dextrose equivalent maltodextrin. These give it superior functional properties, whereas other maltodextrin gels from the starches of corn, tapioca or potato do not possess equivalent fat-like qualities (Inglett, 1991;1993).

Oatrim-5 has at least three health benefits. Firstly, it can eliminate or substitute fat in foods, offering low fat food products because its gel of 25 percent dispersion has only one calorie per gram compared to nine calories for fat. Also Oatrim can be easily incorporated into any consumed foods such as meats, dairy, frozen desserts, baked foods, beverages and others (Inglett, *et al.*,1994; Vatanasuchart,1998). Secondly, Oatrim containing β-glucan soluble fiber gives a lowering cholesterolemic property reported in chicks and humans. The chicks that were fed Oatrim showed a 40 percent reduction in blood cholesterol when compared to controls with a drop in low-density lipoprotein (LDL) cholesterol of 61 percent. Whereas 24 human volunteers with high levels of blood cholesterol consuming Oatrim-enriched diets for 10 weeks appeared an decrease in blood cholesterol levels by 8 percent with a 10 percent drop in LDL cholesterol. In addition, their blood glucose levels decreased by 7 to12 percent which can prove the beneficial effect for diabetics. Lastly, several studies have shown that Oatrim-5 can be used in weight reduction (Kahlon *et al.*1997; Inglett, *et al*.,1994; McBride,1993).

Rate of deterioration of foods by microbial effects is controlled by many factors and one of the most important factors is water. The availability of water can predict the stability of foods and determine the shelf life (Doyle *et al.*,1997). Use of carbohydrate-based substitutes, which were prepared by incorporating water into gel-type structure, results in the high quantity of water content associated with products and may reduce product shelf life (Hassel,1993).

Thus, it was interesting to develop low fat and calorie salad cream through the use of Oatrim-5 as fat substitute and qualify the modified products for the nutritional, physical and microbiological aspects.

MATERIALS AND METHODS

Ingredients

Oatrim-5 is a fat substitute derived from whole oat flour composing (in percent) of moisture, 4.0-8.0; ash, 2.0-3.0; fat (ether extraction), 0.5 maximum; protein (nitrogenx6.25), 5 maximum; and β-glucan soluble fiber, 4.5-5.5 as well as obtaining properties of pH (10 percent solution), 5.5-6.5; dextrose equivalent (DE), 3.0-5.0 and gel strength, 10-14 mm (Inglett,1994). Oatrim-5 is in powder form which can be converted to soft gel by blending into hot water with a 12 percent of Oatrim dispersion for use as vegetable oil substitute in salad cream (Figure 1).

Standard recipe of salad cream and its process of preparation are shown in Tables 1,2 and Figure 2. The Oatrim-5 substituted for vegetable oil was experimented in three levels of 50, 70 and 90 percent by weight basis. In addition, thickening agent such as xanthan gum was tested at a range of 0.1-0.5 percent, for contributing to a proper viscosity and stability of the Oatrim-5 substituted formula. Xanthan gum was mixed with oatrim-5 powder before blending with water to obtain high viscous gel.

Sensory evaluation

Two methods of sensory evaluation were employed for judging the Oatrim-5 substituted samples of salad cream and compared to the control by 25 panelists. Descriptive test with 5-scoring scale would be assigned to rate a range of low to high intensity of characteristics, consisting of a series of descriptive words such as color, aroma, sourness, smoothness, viscosity and flavor. The number 1 represents the least intense and the number 5 means the most intense. In addition, preference test toward the characteristics was used to determine whether or not the panelists liked the modified products when compared to their controls which were evaluated by 9-hedonic scale. The number 1 represents dislike extremely and the number 9 means like extremely (Gatchalian,1989; Lawless and Heymann,1998). The data was statistically processed through ANOVA and DMRT (Pagano,1981).

Nutritional, physical and microbiological evaluation

Salad cream with three levels of Oatrim-5 substitution at 50, 70 and 90 percent as well as the control were assessed for nutritional, physical and

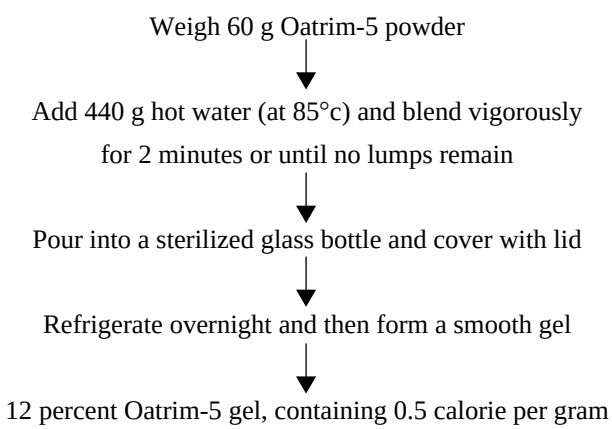

Figure 1 Preparation of 12 percent of Oatrim-5 gel.

Table 1 Composition of salad cream.

Ingredients	Composition	
	Weight (g)	Percent
Whole eggs	50.00	13.75
Fine salt	7.25	2.00
Vinegar	55.00	15.13
Sugar	50.00	13.75
Mustard powder	1.25	0.35
Soybean oil	200.00	55.02
Total	363.50	100.00

Table 2 Proportion of Oatrim-5 gel and soybean oil in salad cream.

Fat and fat substitute	Percent of substitution			
	Control	50 percent	70 percent	90 percent
Soybean oil, g	200	100	60	20
Oatrim-5 gel, g	0	100	140	180
Percent of the Oatrim-5 gel in salad cream formula	0	27.5	38.5	49.5

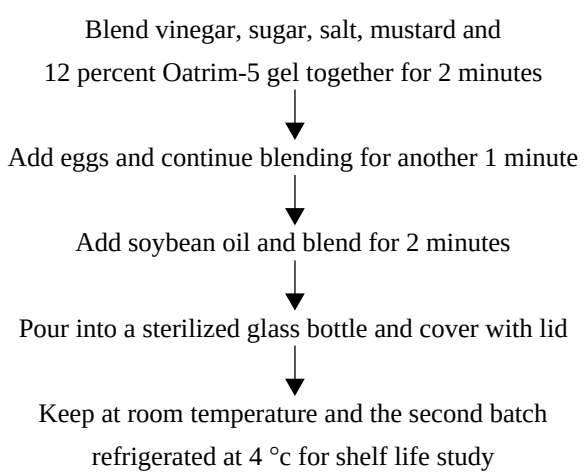

Figure 2 Steps for salad cream preparation.

microbiological quality during storage periods. Proximate composition and total dietary fiber including soluble fiber of the Oatrim-5 substituted salad cream were chemically analyzed using the official methods (AOAC, 1994). For microbiological aspects, total viable plate count, molds, coliforms and aciduric spoilage bacteria were examined for shelf-life quality of the salad creams kept at room temperature and refrigeration temperature of 4°c during storage period of 0, 3 and 6 months (AOAC,1995; BAM,1995). Besides changes of acidity were recorded and stability of salad cream emulsions was observed by measuring height (in cm.) of separated upper layer. Viscosity of the substituted products was determined using Brookfield TC 500 with Rheocale V1.0 operating program.

RESULTS AND DISCUSSION

Characteristics of salad cream substituted with Oatrim-5 gel for vegetable oil were descriptively evaluated using 5-scoring test (Table 3). When three levels of Oatrim-5 substitution at 50, 70 and 90 percent compared to the control, there was no significant difference in sourness. The obtained scores of 3.02-3.40 pointed the moderated taste of sourness. Among the substituted samples, scores of aroma showed no significant difference at between 2.39 and 2.58 , where were below the mean score indicating inferior smell, in contrast to the control obtaining the highest score. Interestingly, the data exhibited that smoothness of the control was not significantly different from salad cream substituted with 90 percent Oatrim-5, but found difference from the others. Since the substituted salad cream at the 50 and 70 percent existed some air-bubbles formed during process of the preparation. This defect might result from mixing an improper amount of less soybean oil with high aqueous portion of oatrim-5 gel leading to the air-bubble formation, instead of producing homogenous oil in water emulsion as the control did. For viscosity scores, there was significantly different among those samples. The control showed the most viscous suspension and the 90 percent substitution obtained the least.

Table 4 showed scores from preference evaluation of the Oatrim-5 substituted salad cream using 9-hedonic scale. The substitution at 50 percent was not significantly different from the 70 percent in most characteristics except viscosity. It seemed that the highest substitution at 90 percent were unacceptable to the panelists due to the lowest preference scores for all characteristics obtained, even though its color and smoothness were quite as good as the control. The results were related to a report of Jettenathammajit, et al. (1999) using modified tapioca starch as a fat replacer. The experimented formulas were varied in dextrose equivalent (D.E. 3 to 5) and concentrations (20 to 30 percent) of the modified tapioca starch for replacement of 30 percent fat content in mayonnaise. Low D.E. and high concentration of the modified starch increased consistency of the mayonnaise. Consumers' acceptability indicated satisfaction of the reduced calorie mayonnaise equal to the full fat formula and was better than commercial lite one.

From the data, salad cream with the 50 and 70 percent substitution with oatrim-5 having no significant difference in overall preference of the characteristics showed the most satisfied levels of substitution to the panelists. Therefore, the lower fat and calorie content of salad cream substituted with the 70 percent oatrim-5 would be possibly applicable if its texture of low viscosity and stability could be solved. In this regard, xanthan gum was a choice for use as thickening agents in the salad cream at a range of 0.1 to 0.5 percent when compared to the control without adding thickening agent. The results from Table 5 presented that color, aroma, sourness, flavor or overall preference of salad

cream was no significant difference among those samples. Whereas viscosity of 0.3 percent addition of xanthan gum gained the highest score, but showed no difference from sample with the 0.1 and 0.5 percent addition.

Weiss (1983) indicated that salad cream being considered as semi-permanent emulsion may contain stabilizing or thickening agents for preventing separation of the emulsions or improving homogeneity, since the increased viscosity retards the separation of semi-permanent. Several polysaccharide gums or cellulose derivatives could be incorporated in the preparation of salad cream and mayonnaise, especially xanthan gum was proved to be an excellent stabilizer (Anon,1993; Hennock,1984).

When texture of the samples was observed, it showed that the more the oatrim-5 gel was used

Table 3 Descriptive evaluation of salad cream using Oatrim-5 substitution for vegetable oil[1].

Characteristics[2]	Control	Percent of Oatrim-5 substitution levels		
		50	70	90
Color, light yellow	2.69[b]	1.89[c]	1.85 [c]	3.46 [a]
Aroma	3.23[a]	2.58 [b]	2.58 [b]	2.39 [b]
Sourness	3.40 [a]	3.02 [a]	3.02 [a]	3.00 [a]
Smoothness	3.96 [a]	2.69 [b]	2.75 [b]	3.85 [a]
Viscosity	4.39 [a]	3.35 [b]	2.58 [c]	1.23[d]
Flavor	3.39 [a]	3.02 [a]	2.98 [a]	2.42 [b]

1 In a row, means followed by same superscript are not significantly different at p>0.05 by ANOVA and DMRT.

2 Evaluated by 5-scoring test: 5 was equal to the most and 1 was equal to the least, comparing three percent levels to the controls of each characteristic.

Table 4 Preference evaluation of salad cream using Oatrim-5 substitution for vegetable oil[1].

Characteristics[2]	Control	Percent of Oatrim-5 substitution levels		
		50	70	90
Color	7.58 [a]	6.50[b]	6.44[b]	6.36[b]
aroma	7.06[a]	6.44 [b]	6.44 [b]	5.64[c]
Sourness	6.81 [a]	6.33 [a]	6.37 [a]	5.81[b]
Smoothness	7.50 [a]	5.73 [b]	5.73 [b]	6.17[b]
Viscosity	7.15 [a]	6.65[a]	5.89[b]	3.96[c]
Flavor	6.89 [a]	6.37[ab]	6.02[bc]	5.56[c]
Overall preference	7.39 [a]	6.64 [b]	6.29 [b]	4.96 [c]

1 In a row, means followed by same superscript are not significantly different at p>0.05 by ANOVA and DMRT.

2 Evaluated by 9-hedonic test:: 9 was equal to extremely like and 1 was equal to extremely dislike, comparing the three percent levels to the control as to each characteristic.

as fat substitute, the less viscous suspension the salad cream would be (Table 6). Likely, the Oatrim replaced salad cream at 70 percent and stabilized with the 0.5 percent xanthan gum had higher viscosity than the other samples, reaching a value at 3070 cp, which closely related to the control at 3740 cp.

As the substitution level of oatrim-5 gel was increased for the low fat salad cream preparation, the analysis data appeared a distinctive decrease in both total fat and energy contents (Table 7). The contents of fat and energy from the control, 50, 70 and 90 percent Oatrim-5 substituted salad cream were 59.39, 29.81,18.71 and 7.24 gram; as well as 595.91, 341.00, 242.00 and 144.00 kcal, respectively. Comparison of the 70 percent substituted sample to the control showed remarkable reduction of fat and energy accounting for 68.50 and 59.39 percent, respectively. According to Thai Food Act. on Nutrition Labelling, foods containing at least 25 percent less fat per reference amount than an appropriate reference food should be

Table 5 Preference evaluation of 70 percent Oatrim-5 substituted salad cream mixed with xanthan gum as thickening agent [1].

Characteristics[2]	Percent of xanthan gum			
	0	0.1	0.3	0.5
Color	6.89[a]	7.14[a]	7.10[a]	7.21 [a]
Aroma	6.90[a]	6.85[a]	6.79[a]	6.77[a]
Sourness	7.08 [a]	6.73 [a]	6.92 [a]	6.71 [a]
Smoothness	7.56 [a]	6.14[c]	5.77[c]	6.71[b]
Viscosity	5.56[b]	6.35[a]	6.83[a]	6.67[a]
Flavor	6.92 [a]	6.87 [a]	6.79 [a]	6.94[a]
Overall preference	6.54 [a]	6.69[a]	6.82[a]	6.90[a]

1 In a row, means followed by same superscript are not significantly different at p>0.05 by ANOVA and DMRT.

2 Evaluated by 9-hedonic test:: 9 was equal to extremely like and 1 was equal to extremely dislike, comparing the three percent levels to the control sample without xanthan gum.

Table 6 Texture measurement of salad cream using Brookfield TC 500 viscometer[1].

Oatrim-5 replacement	Viscosity (cp)	70 percent Oatrim-5 with xanthan gum	Viscosity (cp)
Control	3740.0	0 percent	431.5
50 percent	914.0	0.1 percent	809.2
70 percent	546.9	0.3 percent	1134.0
90 percent	452.5	0.5 percent	3070.0

1 Duplicated samples were incubated in water bath with controlling temperature of 28 c and the measurement was perfomed by Rheocale V1.0 operating program.

claimed to be "reduced in fat" while foods containing 3 gram fat or less per reference amount can be claimed as "low in fat"(Food Act., B.E. 2522). With this regard, the Oartim-5 substituted salad cream at 70 percent level would be claimed to be "reduced fat salad cream", whereas the 90 percent replaced salad cream, composing of 2.17 gram fat per reference amount of 30 gram. could be declared for "low fat salad cream"

When total dietary fiber and soluble fiber were determined, the findings indicated some increase in soluble fiber with the higher replacement of Oatrim-5. The higher soluble fiber in the Oatrim-5 substituted salad cream would present the more content of β-glucan. In several development of low or free fat salad dressings, fat replacers such as simpless, olestra, slendid, modified food starch, microcrystalline cellulose or milk proteins were used, but they could not provide health benefits as oatrim-5 did (Anonymous,1991,1993; Bauer *et al.*,1994; Daugaard, 1992) . Therefore, Oatrim-5 has been proven to be an excellent choice of fat substitute for modification of the low calorie food products.

In addition, examination of microbiological quality was done to ensure safety of the salad cream with oatrim-5 substitution during storage times of 3 and 6 months and compared to the control samples. The total viable count, molds, coliforms and aciduric spoilage bacteria in all of the samples were not found at both room and refrigeration temperature of 4°c. The determination resulted for the values below 10 cfu/g in the first dilution of 10^1, showing no detection of bacteria and mold in all samples and the tests for coliform bacteria were below 3 MPN/g. Some studies revealed survival of microbial cells in a variety of acidic foods including dairy products, salad dressings and orange juice and in particular report of Gahan and Hill (1996) indicated that acid adaptation of *Listeria monocytogenes* could enhance survival in acidic foods and during milk fermentation.

According to the Thai Industrial Standards concerning mayonaise and salad cream, acidity of less than 4.1 is one of qualification needed, therefore salad cream can be defined as acid foods (Thai Industrial Standards Institute, 1997). Table 8 exhibited that high acidity in the salad cream samples, even with the high substitution of Oatrim-5 gel, remaining below 4.1, although at the 90 percent oatrim-5 level seemed to obtain little lower acidity than the other substituted samples. This acidity condition might destroy or inhibit growth of the microorganisms during the shelf life periods, which would ensure the safety for consumption of the low fat salad cream, particularly with the 90 percent substitution of oatrim-5 gel kept at room temperature for 6 months. In addition, the separated upper layer of salad cream representing breakage of emulsions influenced by water content of Oatrim-5 gel was found in salad cream with all substitutions being kept at both room and refrigeration

Table 7 Nutritive values of salad cream substituted with Oatrim-5 for vegetable oil (per 100 g sample).

Samples	Moisture (g)	Protein (g)	Fat (g)	Carbohydrate (g)	Ash (g)	Total dietary fiber (g)	Soluble fiber (g)	Energy (kcal)
Control	22.46	1.89	59.39	13.46	2.80	0	0	595.91
50 percent	48.20	1.86	29.81	16.29	2.65	1.19	0.38	341.00
70 percent	58.18	1.97	18.71	16.47	3.22	1.45	0.70	242.00
90 percent	69.32	1.98	7.24	17.71	2.52	1.23	0.98	144.00

Table 8 Physical changes of salad cream during storage periods of 0,3 and 6 months.

Samples[1]	pH changes			Height of separated upper layer (cm)[2]		
	0	3	6	0	3	6
Control-A	3.80	3.98	3.89	0	0	0
Control-B	3.91	3.94	3.93	0	0	0
50 percent-A	3.97	3.96	3.86	0	1.0	1.0
50 percent-B	3.98	3.98	3.94	0	0.5	1.0
70 percent-A	4.01	4.05	3.97	0	1.5	1.0
70 percent-B	3.98	4.03	3.99	0	1.5	1.0
90 percent-A	4.08	4.04	3.99	0	1.0	1.0
90 percent-B	4.07	4.03	3.98	0	1.0	1.0

1 Samples with A were kept at room temperature and samples with B were refrigerated at 4°c.

2 measured for evaluating stability of their emulsions.

temperature. The results pointed that the storage temperatures did not effect the height of separated layer at the high substitution.

CONCLUSION

Oatrim-5 as fat substitute was suitable for soybean oil replacement in the low calorie salad cream. The panelists accepted the salad cream with 70 percent oatrim-5 gel level with the satisfied scores of characteristics, except smoothness and viscosity. Therefore, addition of 0.3-0.5 percent xanthan gum could achieve the desired texture and overall preference. According to reduction of the fat content, the salad cream substituted with 70 and 90 percent oatrim-5 gel levels would be claimed to be “reduced fat” and “low fat”, respectively. Moreover these salad cream samples were safe for consumption throughout the storage periods. Conclusively, the low fat salad cream developed with Oatrim-5 fat substitution would serve for an increasing demand for low fat foods among Thai consumers at this present time.

ACKNOWLEDGEMENTS

I wish to express my sincere thanks to Dr. George E. Inglett for providing Oatrim-5 as fat substitute for this research and Institute of Food Research and Product Development (IFRPD) for financial support.

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Received date : 21/06/00
Accepted date : 08/11/00