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Optimization of Low Methoxyl Pectin and Calcium Levels in the Low Calorie Sour Cherry Jam

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ABSTRACT

Response surface methodology was applied to develop a low calorie sour cherry jam. A two factor central composite design was employed to optimize the jam in order to obtain a product with adequate sensory properties, especially, overall acceptability. The independent variables were the pectin and calcium concentrations at 5 different levels. All formulations were submitted to 10 semi-trained assessors using a 7-point structured hedonic scale. The highest score for overall acceptability (6.08) was achieved with a jam containing 1.185% pectin and 0.015% of calcium

Keywords: *Response surface methodology (RSM), Sour cherry, Jam, Optimization, LM Pectin.*

INTRODUCTION

Traditional jams (65% soluble solids) are readily available in the groceries and supermarkets. Because of their high sugar content, consumption of jam contributes to overweight and health problems such as diabetes and hyperglycemia. Hyperglycemia is caused by an excessive amount glucose in the blood (180 mg/dl or higher) caused by too little insulin, insulin resistance, or increased food intake (Franz 1996). For consumers who wish to control their weight or other problems related to high sugar consumption, alternative products without or with less amount of sucrose as an ingredient should be made available.

RSM is defined as the statistical tool that used the quantitative data from various experimental designs to determine and simultaneously solve the multivariate equations. RSM explores the relationships between several explanatory variables and one or more response variables (Carley, 2004). RSM has been reviewed (Box and Wilson, 1951; Giovanni, 1983) and has been successfully applied to optimizing conditions in food research. Optimization studies involving only food ingredients or formulations include a peanut beverage (Galvez and Resurreccion, 1990), Tortillas (Holt, 1992), peanut milk based whipped topping (Abdullah and Resurreccion, 1993), liquid whitener (Malundo and Resurreccion, 1993), peanut butter (Hinds, 1994), peanut-sweet potato cookie (Beuchat, 1994), bologna (Carballo, 1995), low-fat frankfurters (Beggs, 1997; Pappa, 2000), pork sausages (Lyons, 1999). extruded snack food (Thakur and Saxena, 2000), South Indian parotta (Indrani and Rao, 2001) , reduced calorie fruit jam (Abdullah and Cheng, 2001), Sweet potato based pasta product (Singh, 2004), Iranian white brine cheese (Alizadeh, 2005), Low calorie mixed fruit jelly (Acosta , 2008) and Jackfruit Sauce (Rittihiruangdej, 2011).

Sour cherry (*Prunus cerasus L.*) is indigenous to Southern West Asia and Europe. Iran is one of the greatest sour cherry producers in the world, and also due to attractive color and distinctive taste and acidity and high phytochemicals content of this fruit, sour cherry is widely used to produce jams and jellies in Iran. Furthermore, a growing number of consumers have created a demand for food products with enhanced characteristics and associated health benefits (Clydesdale 2004), such as high phytochemical content. Because of these reasons we decided to produce a low calorie sour cherry jam.

The objectives of the research were to assess and model effects of two factors or ingredients (Low methoxyl pectin and calcium) at five levels each, on the overall acceptability of a low calorie sour cherry jam, optimize these factors' levels, and determine the nutritional composition of the resulting product.

MATERIALS AND METHODS

Materials

Frozen (−20 °C), ripe sour cherries (*Prunus cerasus L.*) were purchased from a jam factory (SHAHD, Tabriz, Iran). Prior to processing, the fruit was stored for 1 week at −20 °C. Low methoxyl GENU pectin type LM-104 AS, degree of esterification not specified, typically 31%, degree of amidation not specified, typically 17% (CP Kelco, Lille Skensved, Denmark), Calcium chloride, Refined sugar and Aspartame were purchased from a local distributor (Pars Analyze, Tabriz, Iran). Potable water was available at the processing site.

Low calorie sour cherry jam process

At first in order to thawing, frozen sour cherries were held in the laboratory temperature (25 °C) for one hour, then were manually sorted for apparent damage, deseeded, cut with a knife and pureed. The standard formulation (%) for all sour cherry jam treatments consisted of sour cherry (65), sugar (15), aspartame (0.05), low methoxyl pectin (0.5-1.5), citric acid (1), and calcium chloride (0.01-0.02). Water was added in each case to reach 100%. The sour cherry puree was heat processed at 70 ˚C for 10 min. The dry ingredients consisting of low methoxyl pectin and sugar were solved thoroughly in some water to avoid clumping and added to the mixture, which was heated at 70 ˚C for 10 min with constant stirring. Calcium chloride and Citric acid were then added and cooking continued until desirable brix (30) achieved. The jam was hot-filled (80-85 °C) into pre-heated (55.5 ˚C) and pre-sterilized jars, leaving a headspace of approximately 1.3 cm before sealing with fitted covers. Then jars inverted for 5 minute, cooled at laboratory temperature and stored in a refrigerator at 4-7 ˚C.

Sensory evaluation

Panelists were chosen from staff and students at the Food Science and Technology Department, University of Tabriz. They were selected on the basis of having consumed jams regularly, and were warned that the products to be tested contained aspartame (to prevent phenyl ketonurics). The samples were randomly evaluated by10 semi-trained panelists (8 men and 2 women), ages between 18 and 27; five samples in each session, and all assessors evaluated all the samples. Jams were formulated according to the experimental design, prepared 1 week before the first evaluation day, and stored at 4 to 7 °C but warmed to room temperature (21 °C) before serving. Each panelist tasted and evaluated overall acceptability for each formulation by using a 7-point structured hedonic scale (1= dislike extremely; 7=like extremely).

Experimental design and statistical analysis

Response surface methodology (RSM) was used to study the simultaneous effects of low methoxyl pectin (X_1), and calcium (X_2) on overall acceptability of sour cherry jam. After preliminary studies, the upper and lower limits for these variables were established.

Thirteen jam treatments were evaluated according to a Central Composite Design with 3 variables and 5 levels for each variable (Table 1, Table 2).

TABLE 1. Independent variables and levels used in beverage formulation

Variation of levels used in the formula					
Natural variables	-1.41	-1	0	+1	+1. 41
X_1(%)	0.292	0.5	1	1.5	1.707
X_2(%)	0.007	0.010	0.015	0.020	0.022

X_1: Low methoxyl pectin
X_2: Calcium

TABLE 2. Overall acceptability scores for 9 jam formulations, as given by experimental design (mean from 10 evaluations)

RUN	LM PECTIN	CALCIUM	Y
1	-1	-1	3.6
2	-1	1	3.4
3	1	-1	5.2
4	1	1	5.5
5	-1.41	0	3.1
6	1.41	0	4.6
7	0	-1.41	4.3
8	0	1.41	5.1
9	0	0	5.9
10	0	0	5.7
11	0	0	6.2
12	0	0	6.1
13	0	0	5.8

In total, 9 different formulations were produced, and the central point was repeated 5 times. Data from consumer overall acceptability were fitted to response surface equations, and statistical analysis was performed using STATISTICA V5.5 (1999) statistical software.

Physicochemical analyses

Physicochemical analyses were conducted on 3 separate sour cherry jam batches, using the maximized overall acceptability formulation. Three replicates of each sample were analyzed. The pH was recorded on an HANNA pH meter (model pH209., HANNA, Italy). Total soluble solids (TSS) expressed as °Brix of each jam treatment was measured on a bench type refractometer (Bellingham and Stanley, Kent, England). Three replicates for each sample moisture, ash, protein, and total carbohydrate content were determined using methods 920.151, 940.26, 920.152, and 971.18 (AOAC 2005), respectively. Total sugar (%) was determined according to the Lane and Eynon method, 923.09, 920.183b (AOAC 2005). Fat content was determined using the Soxhlet method (ether extraction) with a preliminary sample wash (10 g of dried sample with 5 successive 20 mL water washes) to remove interfering substances such as water-soluble carbohydrates and certain sugars (Carpenter and others 1993). Energy content was calculated using the general factors of 4, 4, and 9 cal g^{-1} of protein, total sugars, and total fat, respectively (Ellefson, 1993).

RESULTS AND DISCUSSION

RESULTS

In most Response Surface Methodology problems, the relationship between the response and the independent variables is unknown. The analysis of variance carried out for the fitted equation for overall acceptability showed that the quadratic model was suitable for the experimental data, as the lack of fit was not significant (P =0.11). The R values for these response variables were relatively high (R^2= 0.95 and adjusted R^2= 0.91).

The following response surface models Equation were fitted to the response variable (Y) and two independent variables (x_1 and x_2):

$$Y1 = 5.94 + 0.727 X_1 + 0.153 X_2 - 1.007 X_1^2 + 0.125 X_1 X_2 - 0.582 X_2^2$$

As can be seen in Table 3, the linear and quadratic parameters of the variables low methoxyl pectin and calcium concentrations except linear parameter of calcium (X_2), significantly influenced ($p < 0.05$) the acceptance of the jam.

TABLE 3. Analysis of variance and regression Coefficients of the regression models

Term	Estimate	Std Err	T	Pr > |t|
X_1	0.727	0.108	6.695	0.0002
X_2	0.153	0.108	1.416	0.199
X_1^2	-1.007	0.116	-8.644	0.0001
X_2^2	-0.582	0.116	-4.997	0.001
X_1X_2	0.125	0.153	0.813	0.442

In accordance with the complete model, a response surface was constructed for overall acceptability of the jam (Figure 1). It can be seen that the surface created by the predictive model indicated a maximum for overall acceptability that would allow the formulation of the optimum jam.

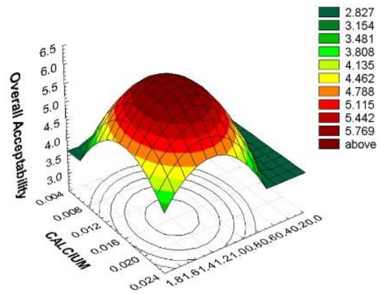

FIGURE 1. Response surface for the effects of variables X_1 (Low methoxyl pectin) and X_2 (calcium) on overall acceptability of the jams produce

Using the STATISTICA (1999) software for response (Y) optimization, the values obtained were X_1 = 1.185 for low methoxyl pectin concentration and X_2 = 0.015 for calcium concentration. The response value (overall acceptability) for these optimum values was 6.08, which corresponds to “like very much” on the 7-point hedonic scale.

DISCUSSIONS

The fact that the linear parameter of both variables was positive indicates that an increase in these variables within the limits studied in this experiment, contributed to an increase in the acceptance of the jam. The quadratic terms of both variables were negative, thus indicating that the stationary point within the experimental region was the maximum to obtain the best acceptance. It can also be observed that the quadratic term for low methoxyl pectin (X_1) was more important than for calcium concentration (X_2).

The R values for these response variables were higher than 0.80 thus there was a satisfactory correlation between regression models and the experimental data, considering that the response variable is a hedonic measurement, which can often present considerable variation as the assessors were semi-trained.

Nutritional Composition

Table 4 shows nutritional composition of the optimized sour cherry jam formulation. As expected, the product contained low protein and zero amount of fat, and its energy content was provided mostly by carbohydrates (from fruit juice).

TABLE 4. Nutritional compositions of the optimized low calorie sour cherry jam formulation

component	percent
Moisture	69±0.8
Protein	0.4±0.1
Fat	0.0
Carbohydrate	32±0.3
Sugars	28±0.5
Ash	0.37±0.05

Data reported as mean ± standard deviation (n = 3).

The pH of the final product was 2.96 ±0.04. One sour cherry jam serving (1 tbsp or 15 mL) provides less than 16 calories (calculated from protein, fat, and sugrs content). The Code of Federal Regulations of The United States (Title 21, Volume 2, Part 101.60b) states the term “low calorie” maybe used on the label or in labeling of foods, provided that the food has a reference amount customarily consumed of 30 g or less or 2 tbsp or less and does not provide more than 40 calories per reference amount customarily consumed (GPO 2007). Therefore, the term “low calorie may be claimed on the product’s label.

CONCLUSIONS

Response surface methodology was used to establish the optimum ingredient levels (low methoxyl pectin and calcium) for overall acceptability of sour cherry jam. It can be inferred that low methoxyl pectin level had a significant effect on overall acceptability, but calcium levels did not. low methoxyl pectin and calcium levels for the formulation that maximized overall acceptability, were 1.185% and 0.015%, respectively. One sour cherry jam serving (1 tbsp or 15 mL) provides less than 16 calories, therefore, it is permissible to claim the term “low calorie” on the product’s label.

REFERENCES

Abdullah A and Cheng TC. 2001. Optimization of reduced calorie tropical mixed fruit jam. Food Qual. Pref. 12: 63-68.

Abdullah A, Resurreccion AVA and Beuchat LR. 1993. Formulation and evaluation of a peanut milk based whipped topping using response surface methodology. Lebensm.-Wiss. u.-Technol. 26: 162-166.

Acosta O, Vıquez F and Cubero E. 2008. Optimization of low calorie mixed fruit jelly by response surface methodology. Food Qual. Pref. 19: 79-85.

Alizadeh M, Hamedi M and Khosroshahi A. 2005. Optimizing sensorial quality of Iranian white brine cheese using response surface methodology. Journal of Food Science, 70(4): S299-S303.

AOAC. 2005. Official methods of analysis of AOAC international. Maryland: AOAC International.

Beggs KLH, Bowers JA and Brown D. 1997. Sensory and physical characteristics of reduced-fat turkey frankfurters with modified corn starch and water. Journal of Food Science, 62(6):1240-1244.

Beuchat LR. 1994. Optimization of a peanut-sweet potato cookie formulation. Lebensm.-Wiss. u.-Technol. 27: 314-318.

Box GEP and Wilson KB. 1951. On the experimental attainment of optimum conditions. J. Royal Statistics Society, Series B. 13(1): 1-45.

Carballo J, Barreto G and Jimenez-Colmenero F. 1995. Starch and egg white influence on properties of bologna sausage as related to fat content. Journal of Food Science, 60(4): 673–677.

Carley KM, Kamneva NY and Reminga J. 2004. Technical Report of Response Surfaces Methodology CASOS. USA: School of Computer Science, Carnegie Mellon University, ISRI-CASOS.CMU-ISRI-04-136.

Carpenter DE, Ngeh-Ngwainbi J & Lee S. 1993. Lipid analysis. In D. Sullivan & D. Carpenter (Eds.), Methods of analysis for nutrition labeling. 85-104. Virginia: AOAC International.

Clydesdale F.2004. Functional foods: opportunities & challenges. Food Tech, 58(12):35- 40.

Ellefson W. 1993. Provisions of the nutrition labeling and education act. In D. Sullivan & D . Carpenter (Eds.), Methods of analysis for nutrition labeling. 3-26. Virginia: AOAC International.

Franz J. 1996. In: Mahan K, Escott-Stump S, editors. Nutritional care in *Diabetes mellitus* and reactive hypoglycemia. In: Krause's Food, Nutrition and Diet Therapy. Philadelphia, Pennsylvania: W.B. Aunders Co. 681.

Galvez FCF and Resurreccion AVA. 1990. Optimization of processing of peanut beverage. J. Sensory Studies 5: 1-17.

Giovanni M. 1983. Response surface methodology and product optimization. Food Technology. 37(11): 41-45, 83.

GPO. 2007. Code of federal regulations (CFR). Washington, DC: US Government Printing Office. Available from http://www.gpoaccess.gov/cfr/. Accessed January 07.

Hinds MJ, Chinnan MS and Beuchat LR. 1994. Unhydrogenated palm oil as a stabilizer for peanut butter. Journal of Food Science. 59: 816-820, 832.

Holt SD, Resurreccion AVA and Mc Watters KH. 1992. Formulation, evaluation and optimization of tortillas containing wheat, cowpea and peanut flours using mixture response surface methodology. Journal of Food Science. 57: 121-127.

Indrani D and Rao GV. 2001. Optimization of the quality of South Indian purottu by modeling the ingredient composition using the response surface methodology. International Journal of Food Science and Technology. 36: 189-197.

Lyons PH, Kerry JF, Morrissey PA and Buckley DJ. 1999. The influence of added whey protein/carrageenan gels and tapioca starch on the textural properties of low fat pork sausages. Meat Science, 51(1): 43-52.

Malundo TMM and Resurreccion AVA. 1993. Optimization of liquid whitener from peanut extract. Lebensm.-Wiss. u.-Technol. 6: 552-557.

Pappa IC, Bloukas JG and Arvanitoyannis IS. 2000. Optimization of salt, olive oil and pectin for low-fat frankfurters produced by replacing pork backfat with olive oil. Meat Science, 56(1): 81-88.

Ritthiruangdej L, Srikamnoy W and Amatayakul T. 2011. Optimization of Jackfruit Sauce Formulation Using Response Surface Methodology. Kasetsart journal of Nature Science, 45: 325-334.

Singh S, Raina CS, Bawa AS and Saxena DC. 2004. Sweet potato-based pasta product: Optimization of ingredient levels using response surface methodology. International Journal of Food Science and Technology, 39: 191-200.

Thakur S and Saxena DC. 2000. Formulation of extruded snack food (gum based cereal-pulse blend): optimization of ingredient levels using response surface methodology. Lebensm.-Wiss u.-Technol. 33: 354-361.