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ORIGINAL ARTICLE

Development of ready-to-eat appetisers based on pepper and their quality evaluation

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Abstract Appetiser is a need based product for defence forces deployed at high altitudes. Ready to eat appetisers in the form of munches i.e. pepper munch and lemon munch were developed by using response surface methodology and central composite rotatable design with active ingredients as variables and quality parameters such as acidity, sugars and sensory acceptability score as responses. The ingredients like raisins and dates were pre-processed by frying in ghee (butter oil) while juice was extracted from pseudolemon and lemon. Pepper was pulverized to a fine powder prior to main processing. The optimized composition of ingredients was processed further by dehydration and concentration technique. The products had 8.7–9.8% fat, 6.5–7.9% protein and 72–73% carbohydrates supplying about 80 Kcals/20 g munch. The appetisers packed in metalized polyester pouches had a shelf-life of 9 months at room temperature (18–33 °C) as well as at 37 °C.

Keywords Appetiser · Pepper · Munches · Shelf-life

Introduction

Appetisers are one of the essential items for the defence forces deployed at high altitudes. Exposure to high altitude is known to cause altitude sickness with such symptoms as headache, nausea and vomiting. Subsequently loss of appetite and reduction in weight are the major problems faced at high altitudes (Rao and Prabhakar 1992; Askew 1996).

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Black pepper, lemon and pseudolemon are traditionally known for their digestive and antiemetic properties. The active compounds of black pepper include piperine, piperedine and chavicine which contribute to pungency. Pungent compounds are known for stimulating the trigeminal nerve (Bryant and Green 1997), enhancing saliva secretion as well as the secretions in the gastro-intestinal tract which improve the digestion (Platel and Srinivasan 2004). To tackle the problem of lack of appetite especially at high altitudes, the inclusion of appetisers in the routine ration scale is a necessity for armed forces. Longer period of stay (6–8 months) at high altitude leads to loss of appetite and reduction in weight (Askew 1996; Singh et al. 1999; Westerterp-Plantenga et al. 1999). Generally carbohydrate rich products are recommended for high altitude. The lemon and pseudolemon are good sources of vitamin C, which is required at high amount at altitudes. Ready-to-eat products are preferred at high altitudes, which can avoid, cooking, fuel use, and energy consumption for reconstitution of dehydrated mixes.

In the present study, two appetisers in the form of ready-to-eat munches have been developed. The optimization of the product has been achieved by statistical design software using response surface methodology (RSM), which is the recent approach widely applied for product development (Chakkaravarthi et al. 2009; Yadav et al. 2009; Wadikar et al. 2008, 2010). The present study aims to provide shelf stable appetisers with good acceptability.

Materials and methods

Jaggery, ghee (Nandini Brand, Mysore), honey (Coorg Brand, Coorg), *Kala namak* (Indian black salt, *Halite*-sodium chloride), black pepper (*Piper nigrum*), cardamom

Table 1 Experimental ranges and levels of independent variables used in RSM in terms of actual and coded factors

Variables	Actual	Coded	Actual	Coded	Actual	coded
Pepper munch						
A) Pepper powder	8	−1	10	0	12	+1
B) Condensed milk	20	−1	30	0	40	+1
Lemon munch						
A) Pepper powder	8	−1	12	0	16	+1
B) Dates	25	−1	32.5	0	40	+1

(*Elettaria cardamomum*), dates (*Phoenix dactylifera)*, raisins (*Vitis vinifera*), pectin (Loba Chemie, Mumbai, India), desiccated coconut, condensed milk (Nestle), lemon (*Citrus limon*), pseudolemon or rough lemon (*Citrus aurantium* Linn.) were procured from the local market. All the materials were cleaned prior to use. The chemicals and reagents used for analysis were of AR grade. Cardamom was decorticated and finely powdered. Black pepper was cleaned and pulverized into a fine powder. Lemon and pseudolemon were washed in hot water, extracted the juice separately and filtered through 60-mesh sieve. The raisins and deseeded dates were fried in ghee at 160–180 °C for 60–90 sec, cooled and ground.

Experimental design For both pepper munch and lemon munch, central composite rotatable design (CCRD) was used to set up the experiment. The statistical design tool Design expert® from Statease Inc. Minneapolis, USA was used to construct as well as to analyze the design. For lemon munch, pepper powder and dates were taken as independent variables, while sensory score and acidity were the two responses. The experimental design of the pepper munch involved condensed milk and pepper powder as the independent variables with sensory score and total sugars as the responses.

Since both appetisers involved only two independent variables the number of design points in each case was 13 with five centre point replications. The independent variables with their coded and actual values with ranges of levels for both the appetisers are given in Table 1. The α-values in the design outside the ranges were selected for rotatability of the design (Thompson 1982). The centre points for these designs were selected with ingredients at levels expected to yield satisfactory experimental results.

Processing of products The pre-processed ingredients of respective appetiser were weighed in proportions as obtained in the experimental design to form different formulations. The appetisers were prepared by concentration and dehydration with continuous stirring while heating in an open pan at 160–170 °C. The hot product was poured into trays pre-smeared with ghee. After cooling, 20 g samples were taken out of the tray and moulded into shapes as individual munches, and packed in metallised polyester before storing at ambient temperature (18–33 °C) and at 37 °C.

Table 2 Design of experiments for pepper munch and lemon munch

Run order	Pepper munch				Lemon munch			
	Pepper powder, g	Condensed milk, g	OAA[a] score	Total sugars, %	Pepper powder, g	Dates, g	OAA[a] score	Acidity, %
1	10.00	30.00	3.52	58.00	12.00	32.50	3.10	0.82
2	10.00	30.00	3.50	58.00	06.34	32.50	3.35	1.20
3	12.83	30.00	3.35	56.50	16.00	25.00	2.40	0.80
4	07.17	30.00	3.68	57.14	12.00	32.50	3.00	0.86
5	10.00	30.00	3.40	57.14	08.00	40.00	2.90	1.10
6	12.00	40.00	3.48	60.00	12.00	32.50	2.95	0.78
7	10.00	44.14	3.57	64.50	08.00	25.00	3.30	1.17
8	08.00	40.00	3.80	61.00	16.00	40.00	2.70	0.75
9	10.00	15.86	2.83	50.00	12.00	32.50	3.10	0.90
10	10.00	30.00	3.53	60.00	12.00	21.89	2.60	0.90
11	12.00	20.00	3.10	55.00	12.00	43.11	2.90	0.88
12	10.00	30.00	3.60	60.60	12.00	32.50	3.20	0.80
13	08.00	20.00	3.33	55.55	17.66	32.50	2.56	0.68

[a] Over all acceptability on 5—point Hedonic scale

Table 3 ANOVA and model statistics of the appetisers

Term	Response			
	Pepper munch		Lemon munch	
Model	OAA[a] score Quadratic	Total sugar Linear	OAA[a] score Quadratic	Acidity Linear
F.value	27.87	21.39	18.12	31.26
P>F	0.0002	0.0002	0.0007	0.0001
Mean	3.44	57.96	2.93	0.90
S.D.[a]	0.072	1.68	0.10	0.044
CV%	2.09	2.90	3.51	4.92
R^2	0.9522	0.8105	0.9283	0.9571
Adjusted R^2	0.9180	0.7726	0.8771	0.9265
Predicted R^2	0.8120	0.6640	0.6946	0.8579
Adequate precision	17.977	13.572	41.141	17.208

[a] Standard deviation, *OAA* Overall acceptability score

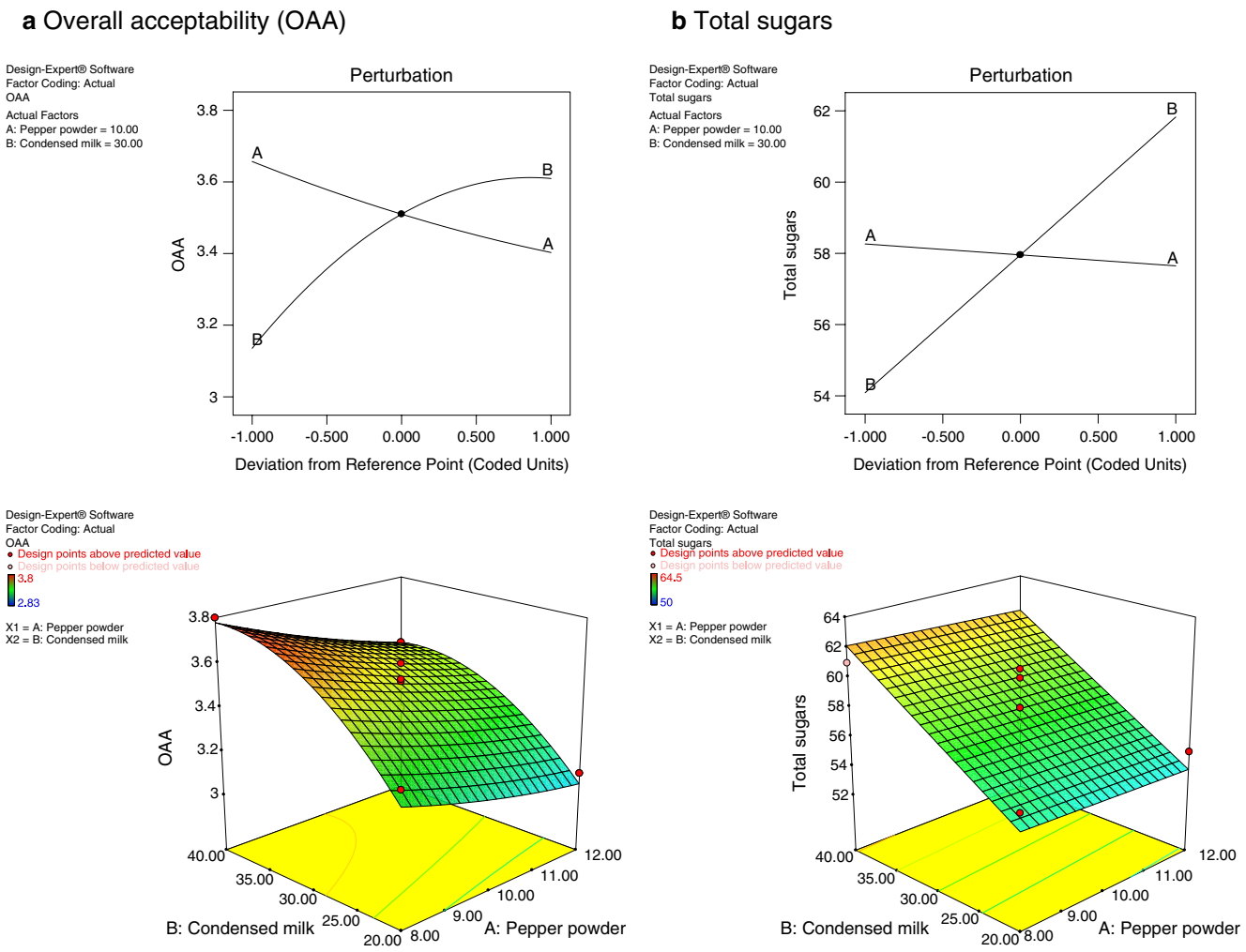

Fig. 1 Perturbation graph and 3D plot depicting effect of independent variables on responses for pepper munch. **a** Overall acceptability (OAA), **b** Total sugars

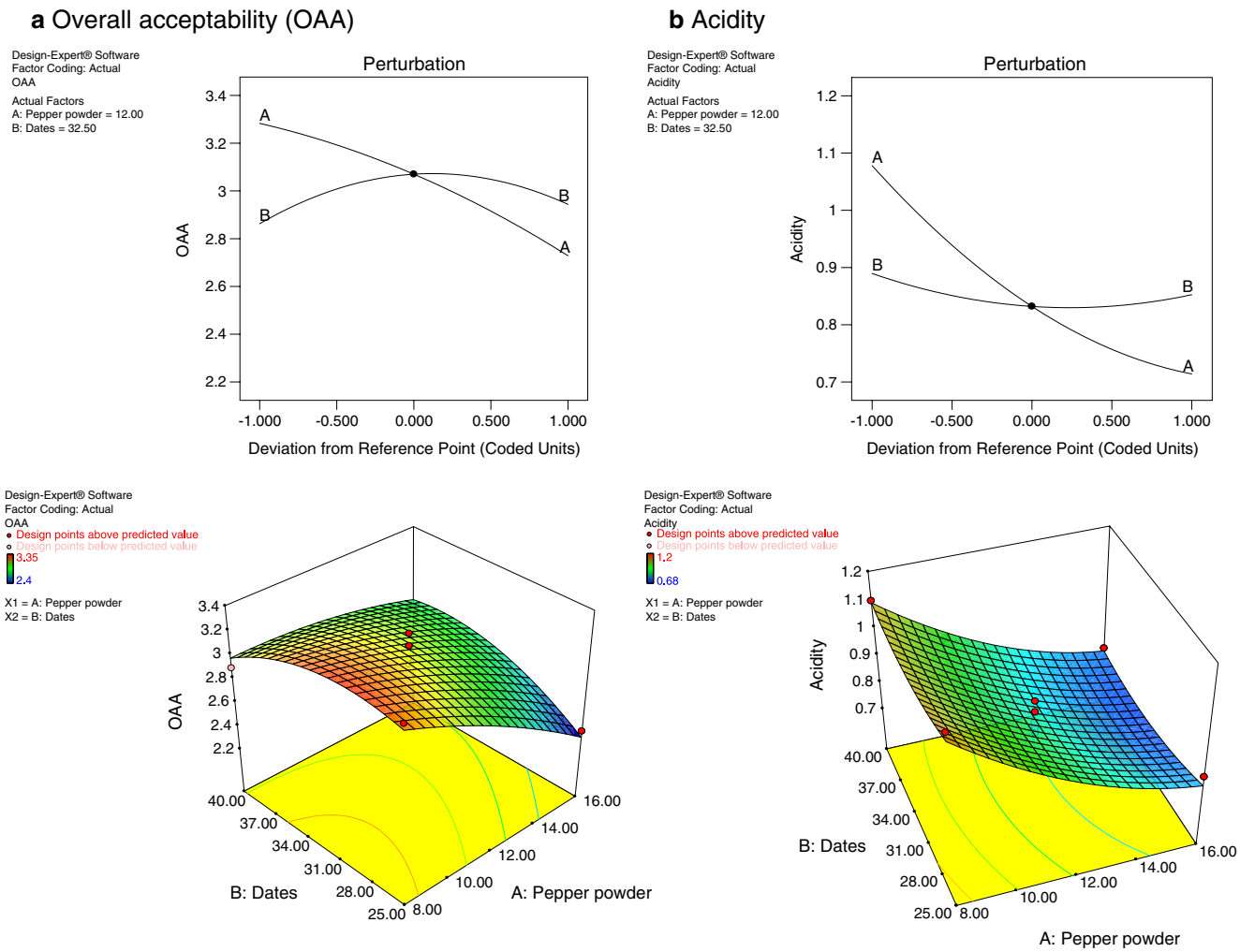

Fig. 2 Perturbation graph and 3D plot depicting effect of independent variables on responses for lemon munch. **a** Overall acceptability (OAA), **b** Acidity

Analysis The acidity was determined by titrometry. The total sugars, total pungency, vitamin C and the proximate analysis of munches were determined by AOAC (1975) and Ranganna (1986) methods. Thiobarbituric acid (TBA) value was estimated by Tarladgis et al. (1960) procedure.

Sensory evaluation Singh et al. (1997) reported altered Hedonic response at altitude and preference for sweet taste. All the combinations of lemon and pepper munch were evaluated for their colour, aroma, taste, texture and overall acceptability on 5-point Hedonic scale with 1 for poor and 5 for excellent rankings by a semi-trained panel of 15 members.

Statistical analysis There were five centre point replications in both designs. The regression analysis of the

Table 4 Proximate composition (%) of appetisers

	Pepper munch	Lemon munch
Protein	7.9	6.46
Fat	9.9	8.7
Crude fibre	3.8	5.6
Ash	2.2	3.1
Carbohydrates by diff.	72.8	72.5
Calorific value (Kcal/ serving of 20 g)	82.3	78.8

Table 5 Changes of munches during storage

Storage period, months	Storage temp, °C	Sensory acceptability score(n=15)		TBA value, mg/kg (n=2)	
		Pepper munch	Lemon munch	Pepper munch	Lemon munch
0	–	3.8	3.4	0.05	0.02
3	RT[a]	3.6	3.3	0.07	0.12
	37 °C	3.2	3.2	0.15	0.22
6	RT	3.3	3.2	0.10	0.14
	37 °C	3.0	3.1	0.18	0.26
9	RT	3.0	3.0	0.20	0.18
	37 °C	2.7	2.9	0.28	0.30

[a] *RT* Room temperature (18–33 °C), *TBA* Thiobarbituric acid

responses was conducted by fitting suitable models represented by generic Eqs. 1 and 2.

$$Y = \beta_o + \sum_{i=1}^{n} \beta_i X_i \quad (1)$$

$$Y = \beta_o + \sum_{i=1}^{n} \beta_i X_i + \sum_{i=1}^{n} \beta_{ii} X_i^2 + \sum_{i \neq j=1}^{n} \beta_{ij} X_i X_{ij} \quad (2)$$

where, β_o was the value of the fitted response at the center point of the design, i.e., point (0, 0, 0) whereas β_i, β_{ii}, and β_{ij} were the linear, quadratic and cross product regression terms respectively and 'n' denoted the number of independent variables. The design expert software was used for all the statistical analysis including ANOVA for models.

Results and discussion

The results of the central composite designs (Table 2) were used to fit the linear and quadratic model as suitable for the each response. The analysis of variance (ANOVA) calculated for each selected model for the response, to assess how well the model represented the data for both appetisers. The p-value i.e. P>F-value (Table 3) for each response are for the model significance which should be less than 0.05 for model to be significant else the model cannot be used for further navigation or prediction

In case of pepper munch, both the responses i.e., overall acceptability and total sugars were more influenced by level of condensed milk than the level of pepper powder (Fig. 1a, b). The influence of variable levels in lemon munch on the responses revealed that the overall acceptability as well as the acidity were more influenced by the level of pepper powder in the product (Fig. 2a, b).

In case of both appetiser munches, the quadratic model was fit for the overall acceptability response as the lack of fit was highly non-significant, while total sugars in pepper munch showed a linear model fit and acidity of lemon munch showed a quadratic model fit.

Multiple regression equations (in terms of coded factors) as obtained for all the four responses of the two munches have been represented as follows.

$$\text{OAA of pepper munch (Y)} = +3.51 - 0.13\text{*A} + 0.24\text{*B} - 0.022\text{*A*B} + 0.020\text{*A}^2 - 0.14\text{*B}^2$$

$$\text{Total Sugars of pepper munch (Y)} = +57.96 - 0.31\text{*A} + 3.87\text{*B}$$

$$\text{OAA of lemon munch (Y)} = +3.07 + 0.28\text{*A} + 0.041\text{*B} + 0.18\text{*A*B} - 0.064\text{*A}^2 + 0.17\text{*B}^2$$

$$\text{Acidity of lemon munch(Y)} = +0.83 - 0.18\text{*A} - 0.019\text{*B} + 0.0005\text{*A*B} + 0.064\text{*A}^2 + 0.039\text{*B}^2$$

The variables were optimized based on the maximization of the overall acceptability score, which is the most important aspect in development of any product. The

solutions were sought to maximize the desirability function for the given criteria by being at random starting points. The best among them with a suitable fit model and maximum desirability was chosen as the optimized composition. The optimized levels of pepper powder in both appetisers was 8 g within the study range whereas the condensed milk and dates level were optimised at 39.5 g and 29.5 g with an desirability score of 0.98 and 0.96 for pepper munch and lemon munch, respectively. It is the correlation coefficient between the optimisation criteria used and the achieved with the help of software. The predicted response and the observed response values were in concurrence with each other. The predicted OAA scores were 3.78 and 3.31 against the actual 3.8 and 3.28 for pepper and lemon munch, respectively. The observed values for total sugars in pepper munch and acidity in lemon munch were 60.35% and 1.0% against predicted values of 61.91% and 1.1%, respectively.

The proximate composition (Table 4) revealed that these two appetisers are carbohydrate rich products with the calorific value ranging from 77.7 to 82.3 Kcal per 20 g. The pepper munch had relatively more fat (9.9%) than lemon munch while the level of the appetite influencing spice in them ranged from 3.5 to 4.5%. The piperine content of the optimised pepper munch and lemon munch was 0.215% and 0.18%, respectively. As the lemon munch contains lemon and psuedolemon juices, the vitamin 'C' in the final product was estimated and was 12±2 mg/100 g.

The storage stability of these munches was studied at different temperatures and the results (Table 5) indicate that the acceptability of the products was very good initially with a sensory score of 3.4 to 3.7 on 5 point Hedonic scale. Even after 9 months of storage, lemon and pepper munches were found acceptable. TBA value, which measures the oxidative change, increased during storage; however, the extent of increase has not influenced the acceptance of the product drastically.

The earlier work reported by Wadikar et al. (2008) was on the development of pepper based appetising mixes in ready-to-reconstitute form with the shelf life of 4–5 months, while the appetisers developed in the present study are ready-to-eat and have longer shelf-life. However, the ingredient compositions differ and ready-to-eat products provide more convenience at high altitude. The pepper based appetiser convenience mixes were very well accepted by consumers in laboratory conditions as well as by Indian soldiers in field conditions of base and high altitude areas (Premavalli et al. 2009).

Conclusion

Two appetisers namely, lemon munch and pepper munch have been developed using response surface methodology. The appetisers were liked by the consumers and these munches have a shelf-life of 9 months at ambient temperature (18–33 °C). These products are most suitable for high altitude areas and in smaller quantities act as a digestive aid.

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