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# Ajowan (*Trachyspermum ammi*) munch: A shelf stable ready-to-eat appetizer, its development and storage

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**Abstract**: Pungent spices such as ginger and ajowan are known for stimulating properties. Appetizers are required in several pathological and geographical stress situations such as prolonged exposure to altitude. The paper deals with the development of a shelf stable ready-to-eat appetizer convenient to the consumer. The central composite design with 3 ingredient variables resulted in 20 experimental combinations with the help of Design expert® statistical software. All these combinations for the appetizer were processed by concentration and dehydration using pre-processed ingredients and evaluated for quality parameters. The optimized product had the proximate composition of 8.6% fat, 7.10% protein and 69.0% carbohydrates, supplying about 76 KCals per munch of 20 g. The munches packed in metalized polyester pouches had a shelf life of 9 months at 28±5°C as well as 37°C storage. The RTE appetizer incorporating ajowan and ginger was developed with excellent sensory properties and shelf stability.

**Keywords: Appetizer, RSM (Response surface methodology), shelf life**

## Introduction

*Trachyspermum ammi*, commonly referred as Bishop's weed, Carom seed (English names) and ajowan or ajwain or omum in Indian languages, is an erect annual herb with striate stem originated in Persia and India. According to Ayurveda, the ajowan seeds are hot, pungent, stomachic, appetizer, aphrodisiac, carminative, laxative and diuretic. Ajowan is traditionally used as remedy for gastric disturbances and as a digestive aid. The thymol & carvacrol derivatives and other minor components from ajowan are responsible for their functional properties (Anilakumar *et al*., 2009, Pathak *et al*., 2010). Apart from ajowan other spices such as ginger, pepper, cumin, chillies, etc, are also known for their stimulating effect. Pungent compounds are known for stimulating the tri-geminal nerve; enhance saliva secretion as well as the secretions in the gastro-intestinal tract which improve the digestion (Bryant and Green, 1997, Platel and Srinivasan, 2004). Traditionally ginger is used in Indian kitchen as well as in Ayurvedic medicines (Premavalli, 2005). The pungent compounds present in ginger (Zinziber officinale Roscob) are gingerol and shaogol which are responsible for its anti-emetic properties (Kawai *et al*., 1994). Ginger is also used for treatment of asthma, shortness of breath, diarrhea, nausea, motion sickness and appetite loss (Stewart *et al*., 1991; Sifton, 1999). Loss of appetite is one of the major problems at high altitude faced by the Indian defence forces. Prolonged stay (6-8 months) at high altitude leads to loss of appetite and reduction in weight (Askew, 1996). Hot water re-constitutable appetizer mixes based on pepper (Wadikar *et al*., 2008) and Ready-to-Eat (RTE) appetizers based on ginger as well as pepper (Wadikar *et al*., 2010a, b) have been reported. The ginger based appetizers were also found beneficial for stimulating appetite and the plasma-leptin levels in human subjects (Wadikar and Premavalli, 2011). RTE products are preferred by soldiers deployed at high altitudes, wherein they can avoid cooking, fuel use, and energy required for preparation of dehydrated mixes. Singh *et al*. (1997) have reported the preference for sweet taste by the consumers at high altitude. Therefore the objective of the study was to develop a RTE appetizer.

The optimization of the product in the present study has been achieved by statistical design software using Response Surface Methodology (RSM), as it has been highly useful and widely applied for product development (Singh *et al*., 2004; Yadav *et al*., 2007; Wadikar *et al*., 2008; Wadikar *et al*., 2010a, b). The study aims to provide shelf stable sweet and spicy appetizer with good acceptability.

## Materials and Methods

### *Raw Materials*

Jaggery, ajowan (*Trachyspermum ammi*) seeds, fresh matured ginger (*Zingiber officinalis* Roscob), raisins (*Vitis vinifera*), ghee (Nandini brand), and honey (Coorg brand) were procured from the local market. Jaggery, ajowan, ginger and raisins were cleaned prior to further use. The pectin (HiMedia) and other chemicals and reagents used for analysis were of AR grade.

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*Raw Material Processing*

The raisins were fried in ghee at 160-180°C for 30-50 sec and cooled thoroughly and were ground. Ginger (fresh) was washed in lukewarm (40-50°C) water, cleaned, peeled and cut into pieces and then was ground into a paste. Ajowan seeds were cleaned and finely ground to pass through 60 mesh sieve.

*Experimental Design*

A central composite rotatable design was used to set up the experimental design. The numbers of design points were obtained based on the number of independent variables taken in the experimental design. The trial version of Design expert® version 8.0 statistical software package from Statease Inc; USA, was used to construct as well as to analyze the design. Ginger paste, raisins and ajowan powder were taken as independent variable with sensory score and cutting force as the responses. The full design with three independent variables had 20 design points including six center point replications. The independent variables with their coded and actual values are given in Table 1. The α-values in the design outside the ranges were selected for rotatability of the design (Thompson, 1975).The center points were selected with ingredients at levels expected to yield satisfactory experimental results. The regression analysis of the responses was conducted by fitting suitable models represented by equations 1 and 2.

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

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

Where $\beta_o$ was the value of the fitted response at the center point of the design, i.e., point (0, 0, 0); $\beta_i$, $\beta_{ii}$ and $\beta_{ij}$ were the linear, quadratic and cross product (interaction effect) regression terms respectively and 'n' denoted the number of independent variables.

*Appetizer processing*

The required amounts of the ingredients were weighed as per the design to form different formulation batches. The appetizer was prepared by concentration and dehydration technique with continuous stirring while heating in an open pan at 160-200°C. In hot condition, the product was poured into trays pre-greased with ghee. After cooling, 20 g samples were weighed and hand-moulded into oval shapes as individual munches, then packed in metalized polyester pouches and stored at ambient conditions (18-33°C) and 37°C.

**Table 1.** Design of experiments (Central Composite Rotatable Design) for Ajowan Munch with coded and actual levels of independent variables as well as the observed responses

| Run Order | *Ajowan* (A) | | Ginger(B) | | Raisins (C) | | OAA Score | Cutting Force (N) |
|---|---|---|---|---|---|---|---|---|
| | Coded | Actual | Coded | Actual | Coded | Actual | | |
| 1 | 0 | 7.5 | 0 | 25 | +α | 35.41 | 8.6 | 3.2 |
| 2 | -1 | 5 | -1 | 20 | -1 | 22 | 8.6 | 1.9 |
| 3 | 0 | 7.5 | 0 | 25 | - α | 18.59 | 8.2 | 1 |
| 4 | 0 | 7.5 | + α | 33.41 | 0 | 27 | 8.27 | 2.6 |
| 5 | +1 | 10.00 | +1 | 30 | -1 | 22 | 7.85 | 2.2 |
| 6 | 0 | 7.5 | 0 | 25 | 0 | 27 | 8.27 | 2.6 |
| 7 | 0 | 7.5 | 0 | 25 | 0 | 27 | 8.2 | 2.4 |
| 8 | 0 | 7.5 | 0 | 25 | 0 | 27 | 8.3 | 2.5 |
| 9 | + α | 11.70 | 0 | 25 | 0 | 27 | 7.5 | 2.75 |
| 10 | 0 | 7.5 | - α | 16.59 | 0 | 27 | 8.5 | 2 |
| 11 | 0 | 7.5 | 0 | 25 | 0 | 27 | 8.5 | 2.38 |
| 12 | 0 | 7.5 | 0 | 25 | 0 | 27 | 8.4 | 2 |
| 13 | +1 | 10.00 | +1 | 30 | +1 | 32 | 8.55 | 3.2 |
| 14 | - α | 3.30 | 0 | 25 | 0 | 27 | 7.8 | 1.8 |
| 15 | 0 | 7.5 | 0 | 25 | 0 | 27 | 8.45 | 2.3 |
| 16 | -1 | 5.0 | +1 | 30 | +1 | 32 | 8.2 | 2.8 |
| 17 | -1 | 5.0 | +1 | 30 | -1 | 22 | 8.15 | 2 |
| 18 | +1 | 10.0 | -1 | 20 | +1 | 32 | 8.11 | 3 |
| 19 | +1 | 10.0 | -1 | 20 | -1 | 22 | 7.7 | 2 |
| 20 | -1 | 5.0 | -1 | 20 | +1 | 32 | 8.17 | 2.4 |

*Over All Acceptability on 9– point Hedonic Scale

*Analytical evaluation*

The acidity was determined by titrometry. The proximate analysis of munch was carried out by standard AOAC procedures (AOAC, 1975). The cutting force was measured using shear press (Chatillon) to get insight of texture of the munch. Changes in the thio-barbituric acid (TBA) value during storage were estimated by steam distillation method as described by Tarladgis *et al*. (1960).

*Sensory Evaluation*

All the combinations of the ajowan munch were evaluated for their colour, aroma, taste, texture and overall acceptability (OAA) on 9-point hedonic scale by semi-trained panel of 15 members during product development as well as storage study. The 9-point Hedonic scale grading was as follows: 9=Excellent, 8=Very good, 7=Good, 6= Good above fair, 5= Fair, 4= Fair above poor, 3= Poor, 2= Very poor, 1= extremely poor. The statistical analysis for significance was carried out using IBM® SPSS® 19 trial version software.

## Results and Discussion

The RTE appetizer munch developed in the present study was ajowan munch. The experimental

central composite rotatable design (CCRD) with different independent variables and the responses used in this study are given in Table 1. Singh *et al*. (2004) used sensory score and texture as responses for optimization of sweet potato based pasta product. Pandey *et al*. (2009) have used a statistical design with 2 variables and only OAA as the response. Since OAA is the most important criteria for acceptability of any product, it was taken as one response while the cutting force was taken as another response as the texture of the chewy munch was an important parameter. The ANOVA and the best fit polynomial models were obtained for both responses (Table 2), to assess how well the model represented the data. The Quadratic Model was fit for the OAA response as the lack of fit was highly non-significant. The cutting force response of the ajowan munch was fit with Linear Model. Both models were fit using design expert software and were highly significant.

**Table 2.** ANOVA and Model statistics of the Appetizer

| | Terms | Response | |
|---|---|---|---|
| | | OAA# score | Cutting Force (N) |
| 1 | Model | Quadratic | Linear |
| 2 | F-value | 17.54 | 31.52 |
| 3 | P>F | 0.0001 | <0.0001 |
| 4 | Mean | 8.22 | 2.35 |
| 5 | S.D.* | 0.10 | 0.22 |
| 6 | CV% | 1.25 | 9.25 |
| 7 | R squared | 0.9404 | 0.8553 |
| 8 | Adjusted R squared | 0.8868 | 0.8281 |
| 9 | Predicted R squared | 0.7738 | 0.7653 |
| 10 | Adequate precision | 15.091 | 17.783 |

* Standard deviation # Overall acceptability score

The response surface plots of the models fit to both responses have been plotted as a function of variables used in the design. The effect of all the variations in levels of independent factors in the designs, on different responses is given in the perturbation graph for each response. The sensory score was influenced by the levels of ajowan powder followed by raisins and ginger powder as represented in the perturbation graph, and further visualized in the 3D surface plot (Figure 1). Another response i.e., cutting force for the ajowan munch was more influenced by raisins level among the three variables (Figure 1).

Multiple regression equations (in terms of coded factors) as obtained for OAA and Cutting force responses for the appetizer munch are

$$\text{Over All Acceptability of Ajowan Munch (Y)} = +8.35 - 0.10A - 0.016B + 0.10C + 0.13AB + 0.19AC + 0.096BC - 0.24A^2 + 0.018B^2 + 0.024C^2$$

$$\text{Cutting force for AjowanMunch (Y)} = +2.35 + 0.21A + 0.14B + 0.51C$$

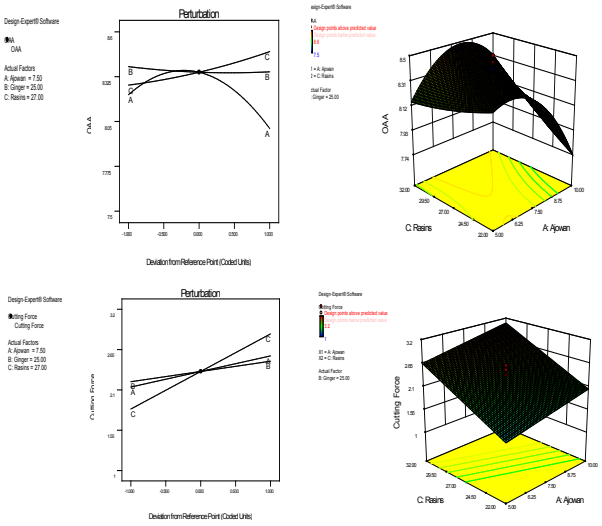


**Figure1.** Perturbation graph & 3D plot depicting effect of independent variables on Overall Acceptability (OAA) and Cutting force for Ajowan Munch

Further the optimization of the variable levels was achieved by desirable maximization of the necessary response along the fitted polynomial models by numerical optimization procedure of design expert software. 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 was chosen as the optimized composition. The optimized levels of the independent variables and the predicted optimum responses along with the desirability score have been represented in Figure 2. The validation of the predictions was done by actual observations recorded for sensory score (8.56 versus 8.61) and cutting force (3.0 versus 3.1). There was not much difference in the actual observations; hence the model equations were highly suitable for predicting the responses. The ajowan munch processed using the optimized ingredients composition was weighed and hand moulded into 20 g munches and was packed in polyester pouches for storage.

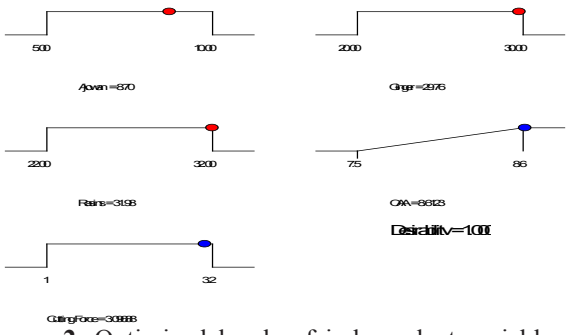


**Figure 2.** Optimized levels of independent variables of Ajowan Munch

**Table 3** Storage changes of Ajowan Munch

| Period (months) | Storage Temp. | Colour | Aroma | Taste | Texture | OAA Score[a] | Acidity (%) | TBA value[b] |
|---|---|---|---|---|---|---|---|---|
| 0 | - | 8.25±0.2 | 8.65±0.6 | 8.55±0.3 | 8.50±0.1 | 8.60±0.1 | 0.48 | 0.03 |
| 2 | RT | 8.15±0.1 | 8.31±0.6 | 8.23±0.4 | 8.31±0.1 | 8.30±0.2 | 0.54 | 0.10 |
| | 37°C | 8.00±0.2 | 8.15±0.1 | 8.15±0.8 | 8.15±0.8 | 8.15±0.4 | 0.60 | 0.18 |
| 4 | RT | 8.05±0.3 | 7.70±0.5 | 8.00±0.8 | 7.85±0.6 | 7.75±0.3 | 0.62 | 0.16 |
| | 37°C | 6.90±0.3 | 7.50±0.3 | 7.50±0.6 | 7.60±0.3 | 7.60±0.7 | 0.67 | 0.24 |
| 6 | RT | 6.78±0.4 | 7.25±0.4 | 7.55±0.2 | 7.63±0.5 | 7.64±0.4 | 0.70 | 0.20 |
| | 37°C | 6.60±0.6 | 6.80±0.5 | 6.92±0.3 | 6.87±0.6 | 6.95±0.3 | 0.78 | 0.27 |
| 8 | RT | 6.85±0.2 | 7.05±0.4 | 6.95±0.6 | 6.95±0.8 | 7.20±0.4 | 0.83 | 0.20 |
| | 37°C | 6.30±0.3 | 6.40±0.8 | 6.40±0.1 | 6.40±0.6 | 6.50±0.2 | 0.89 | 0.28 |

[a]Over All Acceptability on 9-point Hedonic Scale (n=15 panelists)
[b] thiobarbituric acid value (mg malonaldehyde/ kg sample) (n=2)

The proximate composition reveals that the ajowan munch is a carbohydrate (69% by difference) rich product with the calorific value of 76 KCal per serving of 20 g. The protein, fat, ash and crude fibre contents of the optimized munch were.7.25, 9.8, 1.95, and 3.9 percent, respectively. The level of the appetite influencing spices (ginger and ajowan) in ajowan munch was 25.3%.

The storage stability studies (Table 3) of the munch at different temperatures indicates that the acceptability of the product was very good initially with a score of 8.6 on 9 point hedonic scale. After 8 months of storage, ajowan munch was found to be acceptable and was rated above good as the sensory evaluation parameters were not much changed ($p>0.05$). TBA value which measures the oxidative change had increased ($p<0.05$) over the storage period; however, the extent of increase was not considerable for the product quality since it had no objectionable influence on the flavour or acceptance of the product. The TBA values and acidity of the munch differed significantly ($p<0.05$) among the storage conditions of room temperature and 37°C. Yadav *et al*. (2007) have reported a shelf life of 6 months in PP (polypropylene) pouches in ambient conditions, for an instant sweet mix preparation of soybean and semolina, as a result of changes in sensory and TBA values. Similar RTE appetizers based on ginger (Wadikar *et al*., 2010a) and pepper (Wadikar *et al*., 2010b) have been reported with 8-9 months shelf stability in metalized polyester pouches at ambient conditions.

The acceptability of such spice based appetizers in ready to reconstitute and ready-to-eat forms was very well understood at laboratory, base level and high altitude field conditions (Premavalli *et al*., 2009). In conclusion, the RTE appetizer i.e. ajowan munch was developed using response surface methodology and the appetizer munch had a shelf life of 9 months at ambient conditions as well as 37°C. The excellent sensory properties with very common ingredients, long shelf life and appetite influencing ability make the product highly suitable for high altitude areas and sojourners.

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