Optimizing Commodity Properties of Extruded Snack Product Using Rsm

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Abstract*: Rice legume blends were used for the formulation of an extruded product. Response surface methodology (RSM) being a statistical technique was used to evaluate the effect of cowpea (0-20%), groundnut or peanut (0-10%), and feed moisture (14-48%) levels on quality response (moisture of product, ratio of expansion, bulk density, color) of the extruded product. Responses were formulated by box behnken method. Responses were affected most by changes in legume addition and feed moisture. The optimum condition was estimated as level of cowpea 10.64%, level of groundnut 4.14% and level of feed moisture 35.42%.

Key words*: Response surface methodology, box-behnken design, legume addition.

I. INTRODUCTION

Today's food industry dilemma is about the production of breakfast cereals and snacks with the help of local ingredients having high nutritional values to meet the demand of modern people in western countries. To overcome this situation, effective technology such as extrusion cooking is used which doing process such as cooking, drying, disinfectant, etc with the help of mechanical tools.

Extrusion cooking is a continuous flow methodology by which many foods are produced on an industrial basis. Extrusion of texturized proteins is one of the important techniques in food industry. In developing countries, the major protein sources taken from legume and cereals. Proteins have many functional properties. They form interfacial films which stabilize foams and emulsions, can act together to make edible films and gel (A. K. Maurya and P. P. Said).The cereals are fortified with legume protein as rice protein is less efficient than wheat flour and dehulled maize in the formulation of nutritious products. Rice lacks in niacin, thiamine, vitamins C, A and D…etc (Sefa-Dedeh et al., 2000, 2003). The extradite of rice-peanut and cowpea combination has high product acceptability that would act as an alternative and innovative comfortable snack product. Optimizing the Phenolic and anthocyanin extraction of purple sweet potato flour was carried out by RSM method (Elizabeth Amudhini Stephen et al 2019). Optimization using response surface methodology on Soy - cakes by infrared microwave combination (Elizabeth Amudhini Stephen et al 2019). 'Optimizing food materials for development of nutritious pasta 'was done using RSM method (Elizabeth Amudhini Stephen et al 2019).

Response surface methodology (RSM) uses various mathematical, graphical, and statistical method to optimize or develop, improve a process and product, also uses quantitative data and analysis of problems if response variables in influenced by several independent variables. Thus, the main objective of this work was using response surface methodology to evaluate the optimum condition for the formulation of extrusion product.

MATERIALS AND METHODS

RAW MATERIALS

Rice, Peanut and black-eyed Cowpea purchased from local market. The raw materials were stored at 4^{o}C.

PREPARATION OF RAW MATERIAL

The rice and roasted peanut were purified and blended by suitable mill. Legume (cowpea) was dipped in water for 30 min then dried and dehulled using suitable drier.

METHODOLOGY

In the design, expert software the methodology to be followed is to select the Box – Benhken method present in the Response surface methodology. The independent variables are set as the parameters, which are level of cowpea, level of groundnut, level of feed moisture, which is to be estimated. Then set the responses (moisture of product, ratio of expansion, bulk density and color) and assign them in the Design Expert Software of Version 11.

EXPERIMENTAL DESIGN

The output taken from primary studies (Saalia, 1995) was used to choose the range of barrel temperature from 155^{o}C-165^{o}C.due to this, the number of variables used in the experimental design should be decreased. The study of combined effect on the independent variable like level of cowpea (A), level of peanut(B) and level of feed moisture (C). Based on the Box-Benhken method the experiment was conducted with quadratic model. In the Box-Benhken design a number of 15combination having, four replicates were carried for the chosen variables in the table 1. The dependant variables (Y) measured for the extruded rice-legume blends were moisture of product (Y_1), ratio of expansion (Y_2), bulk density (Y_3) and color change (Y_4). The response variables are the function of independent variables, which are expressed individually by the dependant variables. The Second order polynomial is used as a function for the variance were accessed for each factor and they are separated into linear, quadratic and inter active components and they are expressed as follows.

Product moisture (Y_1) = 7.62431 + 0.075588 A + 0.54426 B + 0.035221 C – 0.027300 AB + 0.003529 AC – 0.010441 BC

Expansion ratio (Y_2) = 4.76154 - 0.099742 A – 0.261709 B – 0.102478 C –

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0.002500 AB + 0.004199 AC + 0.0007247 BC

Bulk density (Y_3) = 2.56347 - 0.092081 A – 0.141209 B – 0.052132 C – 0.00540 AB + 0.002665 AC + 0.0005247 BC

Color change (Y_4) = 30.39090 – 0.332787 A -0.678118 B – 0.110748 C + 0.029950 AB +0.007529 AC + 0.040794 BC + 0.009150 A^2

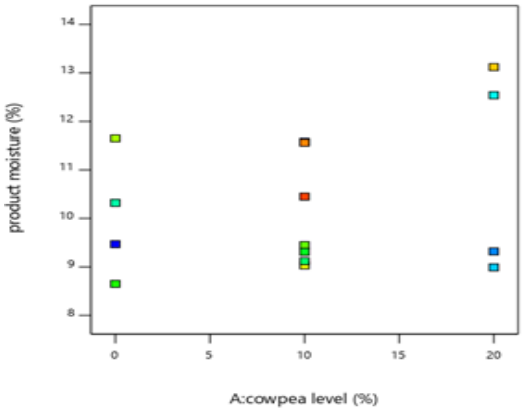
Table 1.experimental design developed using box-behnken design

Std	Run	Factor 1 A:cowpea level %	Factor 2 B:groundnut level %	Factor 3 C:feed moisture ... %	Response 1 product moisture %	Response 2 expansion ratio	Response 3 bulk density g/ml	Response 4 total colour cha...
7	1	0	5	48	9.47	0.703	0.456	20.32
10	2	10	10	14	11.58	0.956	0.564	15.18
6	3	20	5	14	9.32	1.26	0.325	25.36
4	4	20	10	31	8.99	1.23	1.012	30.15
8	5	20	5	48	12.54	2.123	1.235	24.32
1	6	0	0	31	10.32	0.809	1.095	18.35
15	7	10	5	31	9.12	0.723	0.987	18.02
14	8	10	5	31	9.31	2.369	0.895	25.37
5	9	0	5	14	8.65	2.695	1.358	26.48
9	10	10	0	14	9.45	3.126	1.412	29.36
3	11	0	10	31	11.65	0.756	1.426	19.26
12	12	10	10	48	9.03	1.103	1.503	18.72
2	13	20	0	31	13.12	1.783	0.789	23.25
13	14	10	5	31	11.56	3.234	0.369	30.02
11	15	10	0	48	10.45	0.809	0.567	19.03

II. RESULT AND DISCUSSIONSTATISTICAL ANALYSIS

The experimental values and the analysis of variance are obtained for four response variables, which are moisture of product, ratio of expansion, bulk density and color under varying treatment conditions. The models were developed for evaluate the product and process condition of extruded snack product. It characterized that it was adequate for all response variables, which are developed, in the response surface model. The reaction was explained well by the regression model for all these response variables.

PRODUCT MOISTURE



Product moisture predicts the shelf life of the products. It was observed that by decreasing product moisture the shelf life of the product would be increased. The moisture of product, ratio of expansion, bulk density of rice extradite was lesser than the extruded of rice-legume blends. Addition of peanut and cowpea level increases resulting in decreasing the expansion ratio while increasing the product moisture and bulk density. The models created to determine the product moisture in the design was found to be F-value of 0.8963, which implies that the model is not significantly fit.

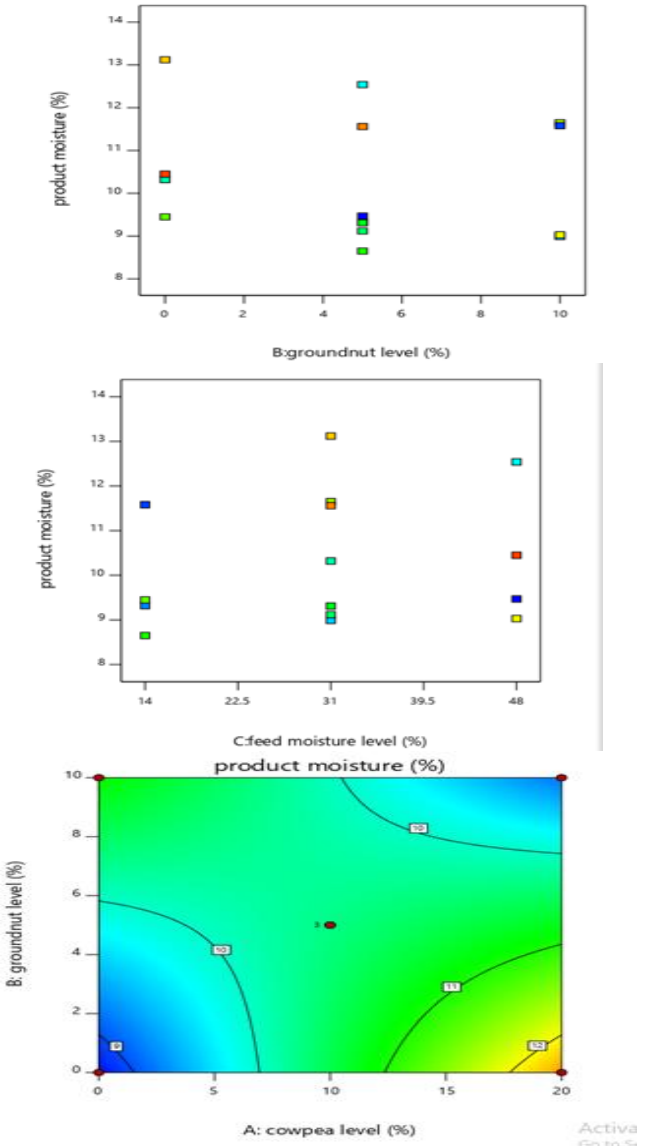


Fig1: (a), (b), (c) represents the experimental moisture of product of level of cowpea, level of peanut level and level of feed moisture.(d) Indicates the relationship of moisture of product with that level of cowpea and level of peanut

EXPANSION RATIO

The formula of expansion ratio is provided by $ER=D^2/d^2$, where diameter of the die hole denoted by D (mm) and the diameter of the extradite denoted by d (mm). The expansion ratio defines as the degree of puffing by extruder. This is the important property in the extruded products being RTE and convenience snack by food processing industries. The models created to determine F-value of 1.45 implies is not significant. There is 30.64% large F-value could occur. The model indicates after cowpea addition, the ratio of expansion of the product has to be increased.

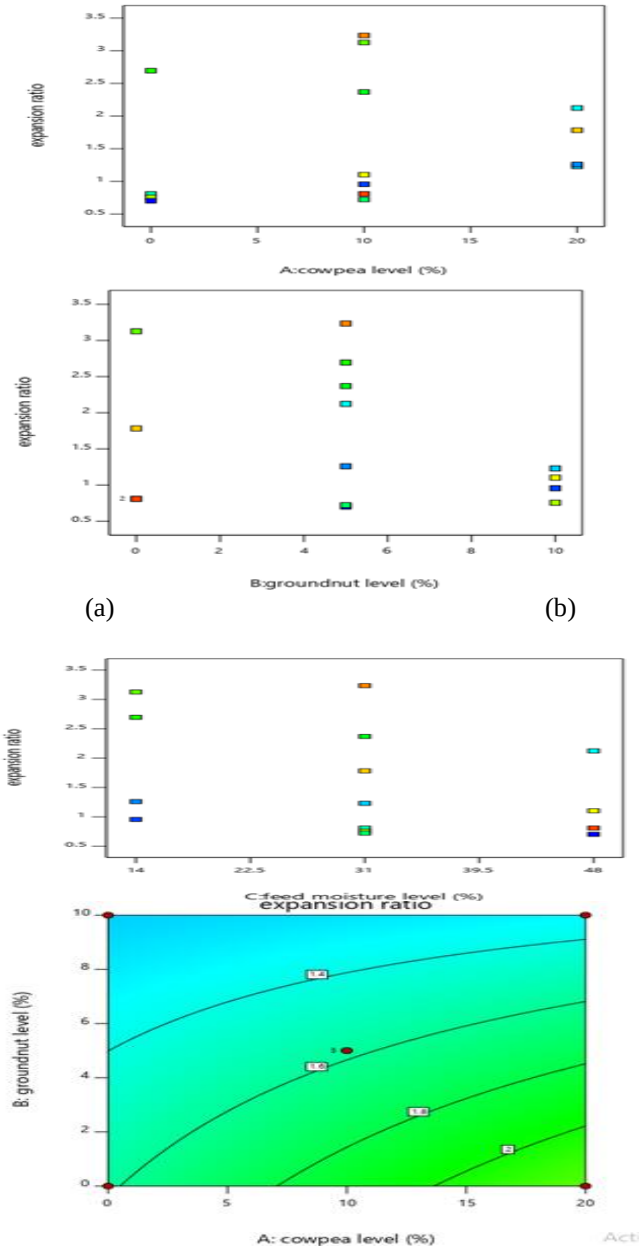


Fig 2: (a), (b) and (c) represents the relationship of experimental ratio of expansion of level of cowpea, level of peanut and level of feed moisture. (d) Indicates the relationship of level of expansion with that level of cowpea and level of peanut.

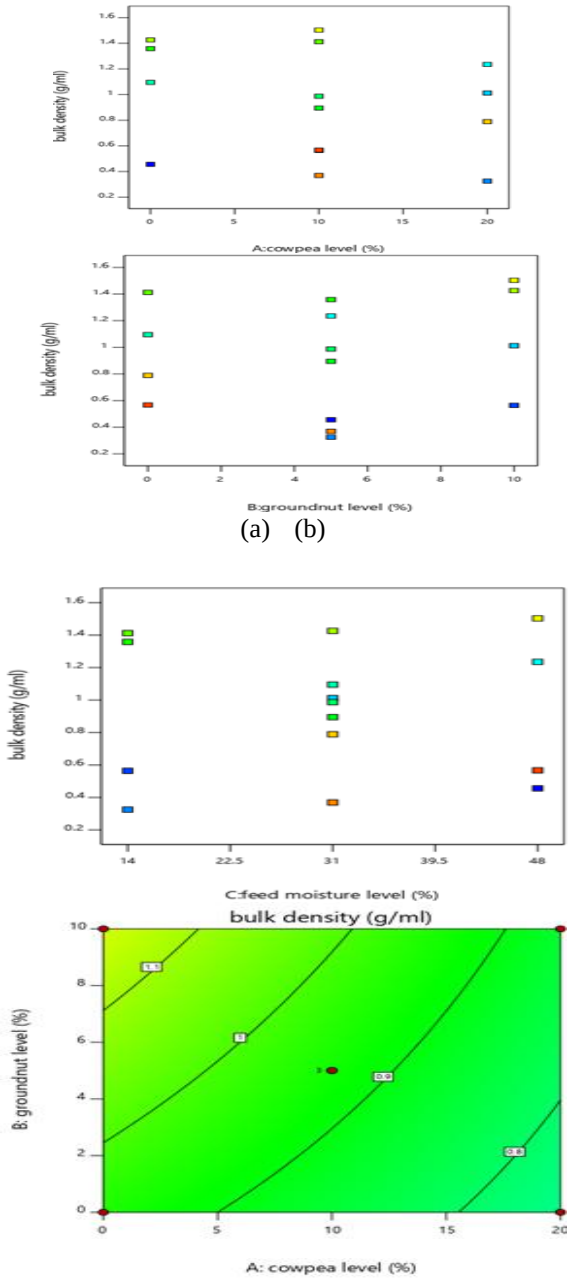


Fig 3: (a), (b) and (c) represents the relationship of experimental bulk density of level of peanut, level of cowpea and level of feed moisture. (d) Indicates the relationship of ratio of expansion with that level of cowpea and level of peanut.

BULK DENSITY

The technique of Barrett & peleg (1992) used for identify the bulk density. The degree of puffing of extradite can be estimated by the bulk density and expansion ratio of the product. The models created to evaluate the bulk density of the extruded project, which implies the model is not significant at the F-value of 4.58. The models are significant at the p-values below 0.0500.

COLOR CHANGE

The color change between the different runs of extruded blend range from 15.18 to 30.15.The models created to evaluate the color change of the extruded blend, which implies the model is not significant at the F-value of 1.06. The models are significantly fit at the p-values below 0.0500.

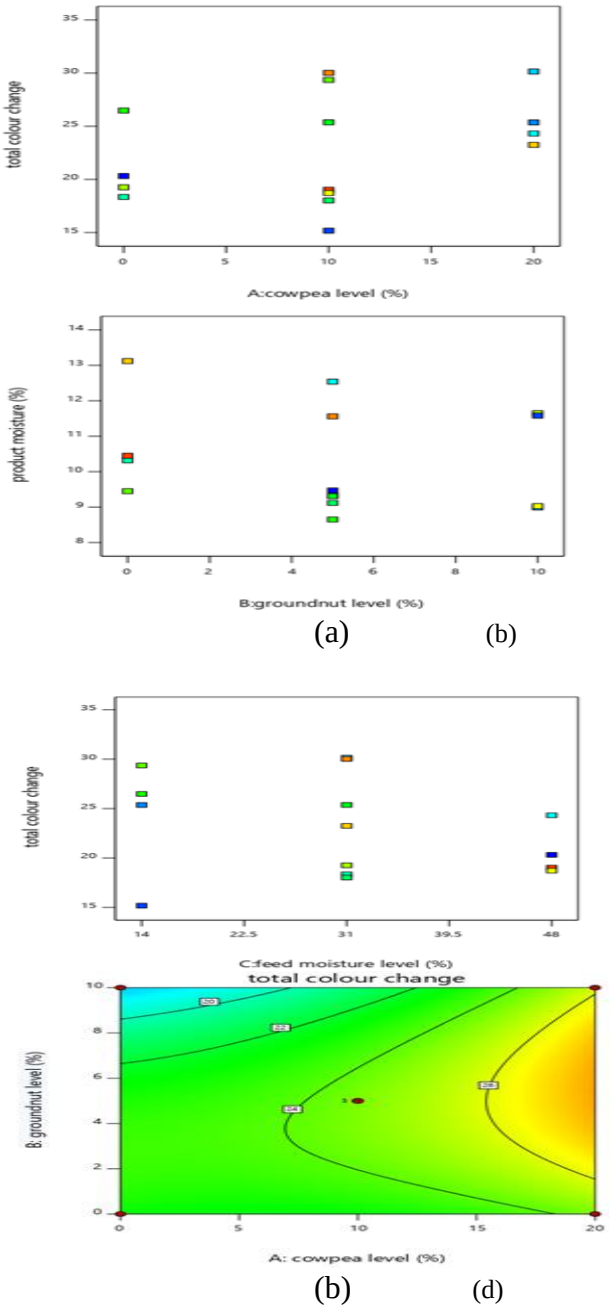


Fig 4: (a), (b) and (c) represents the relationship of experimental color change of level of cowpea, level of peanut and level of feed moisture. (d) Indicates the relationship of color change with that level of cowpea and level of peanut.

III. CONCLUSION

These different conditions like level of cowpea, level of peanut and level of feed moisture of the extruded blend revealed that these variables affect the moisture of product, ratio of expansion, bulk density and color change of the extruded product. The second order polynomial helps us to connect these with the legume addition. The operating variables optimum set is determined through the contour plots, for obtaining a suitable concentration of the level of cowpea, level of peanut and level of feed moisture based product characteristics.

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