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Effect of Processing conditions on Functional properties of extruded product from carrot and rice blend

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ABSTRACT

A study was conducted in the division of Food Technology, SKUAST -Kashmir to develop carrot incorporated rice based extruded snacks during the year 2016-2017.Response Surface methodology (RSM)was used to study the effect of carrot incorporation, Feed moisture ,screw speed and Barrel temperature on responce variables. Central composite rotatable design (CCRD)with carrot incorporation (10-30%),Feed Moisture(11-17),Screw speed (200 -400rpm) Barrel temperature of (120-180℃) as independent variables produced 30 different combinations that were used to investigate the effect of these variables on Functional properties likes specific mechanical energy(SME),Bulk density.The independent responses -Carrot incorporation, feed moisture ,screw speed .and barrel temperature significantly effected the product response. With the increase in screw speed SME increases .While feed moisture barrel temperature and composition decreases the SME . With the increase in carrot incorporation ,screw speed and temperature may reduce the bulk density while feed moisture increases bulk density

***Key words* Broken Rice, Carrot ,Extrusion ,RSM**

I INTRODUCTION

Broken rice, a by-product of modern rice milling process has nutritive value similar to whole rice and is available readily at relatively lower rates. Rice flour has become an attractive ingredient in the extrusion industry due to its bland taste, attractive white color, hypo-allergenicity and ease of digestion.It can serve a very good base for production of extruded products

The carrot (Daccus carota) is a root vegetable , rich source of β -carotene and other vitamines(zohul.,2002).carrot is also an excellent source of calcium -pectate , pectin fiber that has the cholesterol lowering properties. It reduce the risk of blood pressure ,stroke ,heart diseases .Carrot is economically an important horticulture crop that has gained popularity in recent decades due to increased awareness of its nutritional value.Orange coloured carrots are considered as good for eyes due to their high content of phytochemicals that aften are precursors to vitamine A.∂ and β are also predominant in orange coloured carrots.

Extrusion cooking is a high -temperature short time (HTST) processing technology . An extruder is bioreactor in which ,raw food material with different moisture content and consistencies are treated under strong shear forces .The raw material is is thus converted to a highly elastic mass which is extruded through die.

II MATERIALAND METHODS

The present investigation entitled

Processingn and Physical Properties of Extruded Product From Rice and Carrot blend" was carried out in the Division of Food Technology ,Sher-e-Kashmir University of Agricultural Science and Technology of Kashmir _SKUAST-K) Shalimar during 2016-2017.The section enlist the material used and elaborates the processing techniques, analytical procedures during the research.

Experimental material

Raw material used in the investigation

Widely cultivated paddy variety(Jhelum)obtained from Mountain Research Centre fpr Field Crops ,SKUAST-K, Khudwani.Anantnag was milled at Division of Food Technology ,SKUAST-Kashmir, Shalimar using mini rice mill(Model:ASR RM 09).The small rice broken (<_1/8) 0f actual kernel size and carrot (Nantes)from (vegetable science)moisture dried to 12% in rice and in carrot to 6% before grinding and were ground to finenssthat passes through 200μm sieve and stored under ambient conditions in high density polyethylene (HDPE) for further use.

Extrusion process

The extrusion experiment was performed in a co-rotating intermeshing twin screw extruder (ClexBC-21,Firminy, France) at department of food technology SKUAST -Kashmir.The barrel diameter and its length to breadth ratio were 2.5mm and 16:1 respectively . The extruder barrel is divided in to four zones.Temperature of first secound and the third zone was varied was maintained at30,60,90 respectively, through the experiment ,while the temperature at the fourth zone was varied to the experimental design .The extruder was equipped with a torque indicator , which showed per cent of torque in propertion to be current drawn by the drive motor .Blended materials were ten metered in to the extruder with a single screw volmetric feeder(DSandM,Modena Italy) .The feed rate was varied for the optimum filling of the extruder barrel corresponding to screw speed The moisture content of the feed was adjusted dy injecting water (approximately 30℃)in to the extruder with a pump

Experimental design

CCRD for the four independent variables was performed .The independent variables considered were composition i.e Rice flour : Carrot flour(A), moisture(B),screw speed(C) and Barrel temperature(D).The independent variables and variation levels are given below in Table 1.1

Response surface methodology was applied for experimental data

The results were analysed by **a** multiple regression model which describes the effects of variables in the models derived .Experimental data were fitted to the selected models and regression coefficients were obtained .The Analysis of Variance (ANOVA)tables were generated for each of the responce functions .The individual effect of each variable and also the effects of interaction term in coded levels of variables were determined
Responses obtained as a result of the proposed experimental design were subjected to regression analysis in order to assess the effect of composition ,moisture content ,screw speed and barrel temperature on product characteristics.Secound order polynomial regression models were established for the dependent variables to fit experimental data for each response using statistical software Design -Expert 10(Stat-Ease Inc, Mineapolis, MN, USA).

SME(Specific Mechanical Energy)

specific mechanical energy (Wh/ g) was specific mechanical energy (Wh/ g) was calculated from rated screw speed (682),motor power rating (8.5k), actual screw speed ,per cent motor torque and flow rate (kg/ hr) using calculated using formula(Pansawat *et al*. (2007)

SME= Actual screw speed(rpm) /Rated screw speed × %motor torque 100×

motor power rating / mass flow rate(kg/h)

Physical properties of extruded snack

Bulk density

(weight/unit volume)

The densities of extrudates were determined by volmeteric displacement procedures as the volume of the expanded sample was measured by using a 100 ml graduated cylinder by raped seed displacement .The volume of 20g randomised sample was measured for each test .The ratio of sample weight and the replaced volume in the cylinder was calculated as bulk density (W/V)

composition	Moisture	Screw speed	Barrel temperature	SME	B D
80:20	17	300	140	12.2	0.2
80:20	17	300	140	12.2	0.2
80:20	17	300	140	12.4	0.4
80:20	17	300	180	12.3	0.2
80:20	17	400	140	12.5	0.2
80:20	11	300	140	12.4	0.3
70:30	14	250	120	12.4	0.1
80:20	17	200	140	12.2	0.4
70:30	14	350	120	12.4	0.1
90:10	14	250	160	13.1	0.7
80:20	17	300	140	12.1	0.4
90:10	20	350	160	13.1	0.6
90:10	20	350	120	12.3	0.5
80:20	23	300	140	12.6	0.4
60:40	17	300	140	12.1	0.2
80:20	17	300	140	12.2	0.4
90:10	20	250	160	13.1	0.7
80:20	17	300	100	12.4	0.4
90:10	14	250	120	12.1	0.6
90:10	14	350	120	13.1	0.5
70:30	20	350	160	12.4	0.1
90:10	20	250	120	12.1	0.7
70:30	20	250	160	12.4	0.1
100:0	17	300	140	13.4	1
80:20	17	300	140	12.6	0.4
70:30	14	350	160	11.7	0.1
70:30	14	250	160	12.4	0.1
70:30	20	350	120	12.3	0.2
70:30	20	250	120	12.2	0.3
90:10	14	350	160	13.4	0.7

Results and Discussion

Effect of processing conditions on specific mechanical energy(SME)

The amount of mechanical energy delivered to the extruded material plays an important role in starch conversion .Higher SME usually results in greater degree of starch geletinization and extrudate expansion .The mean values of SME under different extrusion conditions listed in the(table 1.1)ranged between 11.2-13.4 Wh/kg .Regression analysis was carried out to fit the mathematical models to the experimental data. The predicted model for SME can be described by the following equation in terms of coded levels.

+12.47-0.28A-0.013 B+0.0062C+0.10D+0.094AB-0.13AC-0.019BC+0.094BD-0.11

ANOVA for SME and BD(Table1.2)

Regression	SME(Wh/kg)	Bulk density(kg/m3)
R-squared	0.7500	0.9463
Adj-R^2	0.6184	0.8962
Pred-R^2	0.2722	0.8349
Adeq-pression	9.324	18.384
C.V%	2.05	20.26
Lack of fit	N.S	N.S

The significance of coefficient of fitted quadertic model was evaluated by using F-test and p-value.The analysis of variance (ANOVA) for SME given in the figures1showed negative effect of composition ,moisture ,while positive effects of screw speed and temperature on SME. Similar result was found by (Meng *et al*,) that SME increased proportional to the screw speed., although a decrease in SME was also expected because melt viscosity would decrease with increase in SS. This result indicated that the effect of SS dominated the effect of melt viscosity thus witnessing decrease in SME (Bhattacharya *et al*32 (1), 83–99)

Effect of processing condition on bulk density

Bulk density

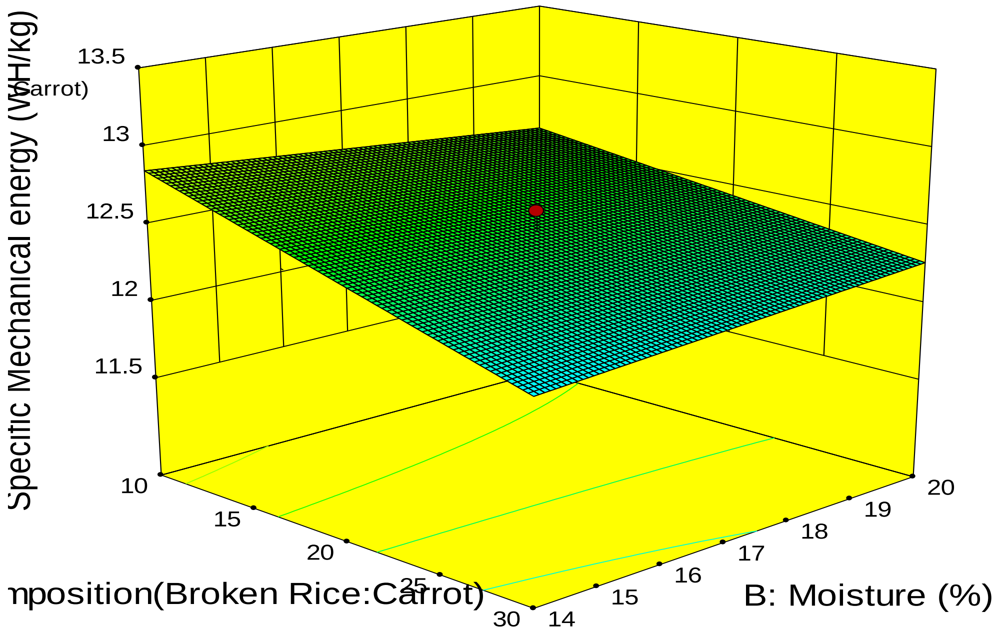
Bulk density measures how much expansion has occured as a result of extrusion and important parameter of extruded product .The heat developed during extrusion can increase the temperature of moisture above the boiling point .When the extrudate exits the die , a part of moisture, will flash off as steam and results in an expanded structure with larger alveoli and low density. on the other hand if enough heat is not generated to flash off enough moisture ,less expansion will occur which results in high bulk density product with collapsed cells which usually disintegrates on cooling.

Model Equation for Bulk density

0.33-0.22A+0.021B-0.038C-0.013D+0.019AB+0.019AC-0.044AD-0.019BC-0.031BD+0.019CD+0.066A^2+3.125E-003B^2-9.375E-003C^2-9.375E-00

The bulk density of extrudates varied between 0.1-0.7 kg/m ANOVA for the model showed positive relation of moisture and inverse relation of screw speed, composition ,and barrel temperature with bulk density perceived from Figure 1 that bulk density initially increased with carrot proportion, which may be because of more water binding property of non starch polysaccharides than protein and starch . However, it decreased with the Carrot proportion, which may be attributed to lighter mass of the fiberin carrot incomparison to other constituents. The bulk density initially decreased with moisture content, which may be due to proper gelatinization and higher expansion,where as further increase in bulk density may be because of reduction in elasticity of dough and lower expansion as reported by Ding et al. (2005, 2006).The contour plot in Figures (abcde)demonstrate the initial increase in bulk density with the increase in temperature, which may be due to the presence of carrot in the feed formulations, whereas further decrease in bulk\density with the increase in temperature may be attributed to higher expansion (Ding et al., 2006 reduction in elasticity of dough and lower expansion as reported by Ding et al. (2005, 2006)

figure1. Effect of composition and moisture on specific mechanical energy



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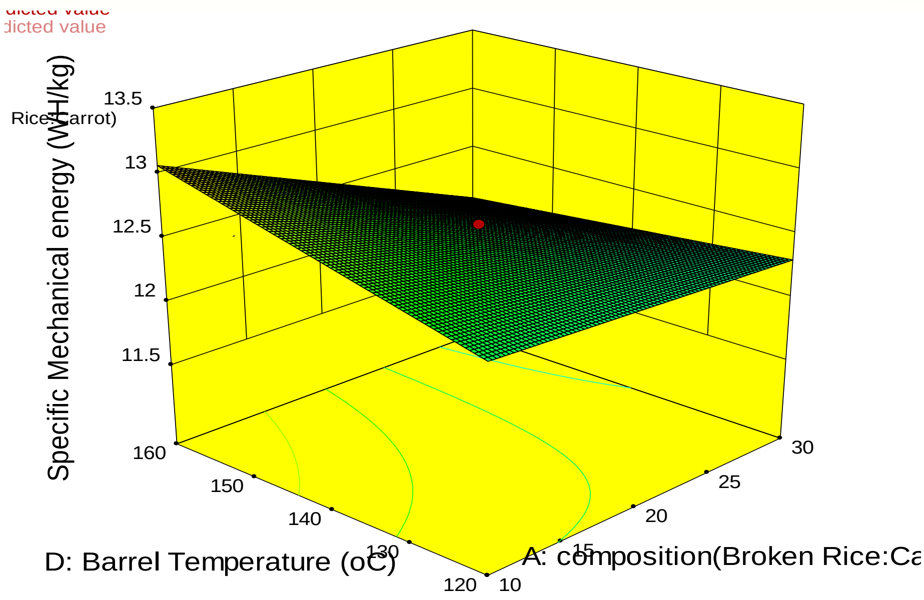

figure 1.effect of barrel temperature and composition on specific mechanical energy

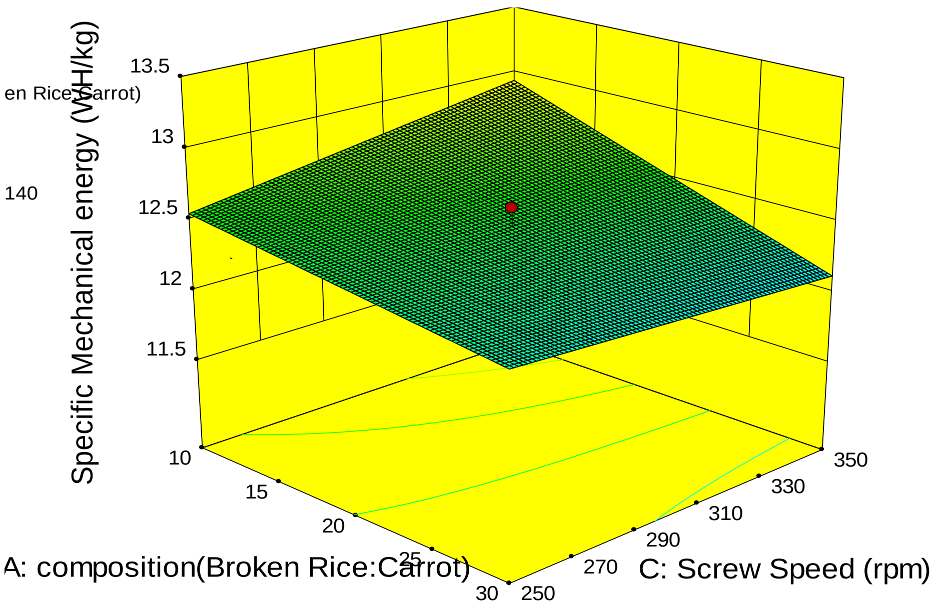

Figure1. Effect of composition and screw speed on specific mechanical energy

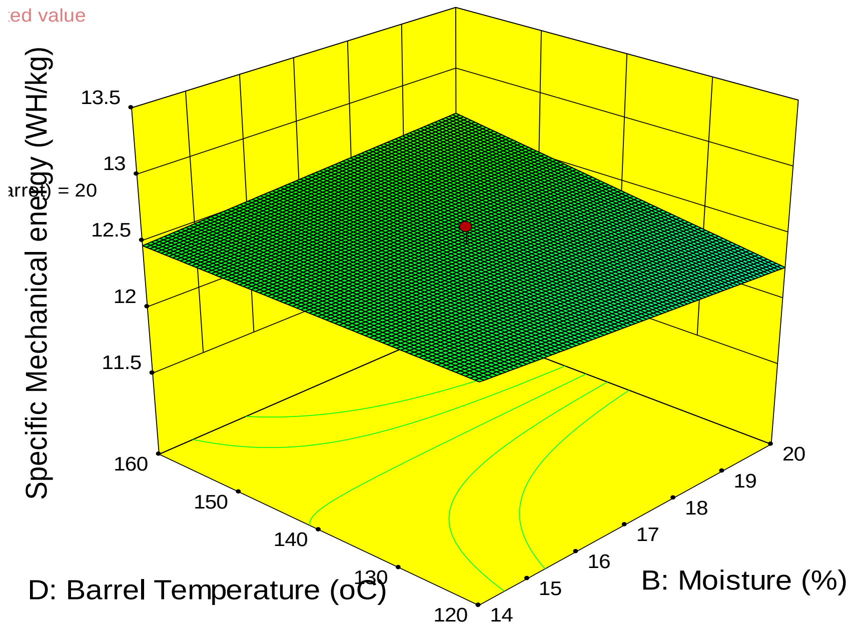

Figure 1.Effect of barrel temperature and moisture on specific mechanical energy

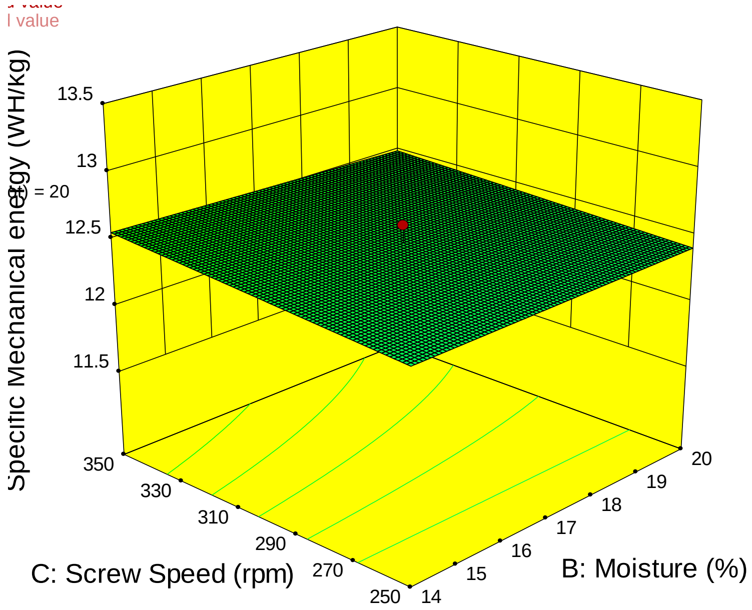

Figure1.Effect of screw speed and moisture onspecific mechanical energy

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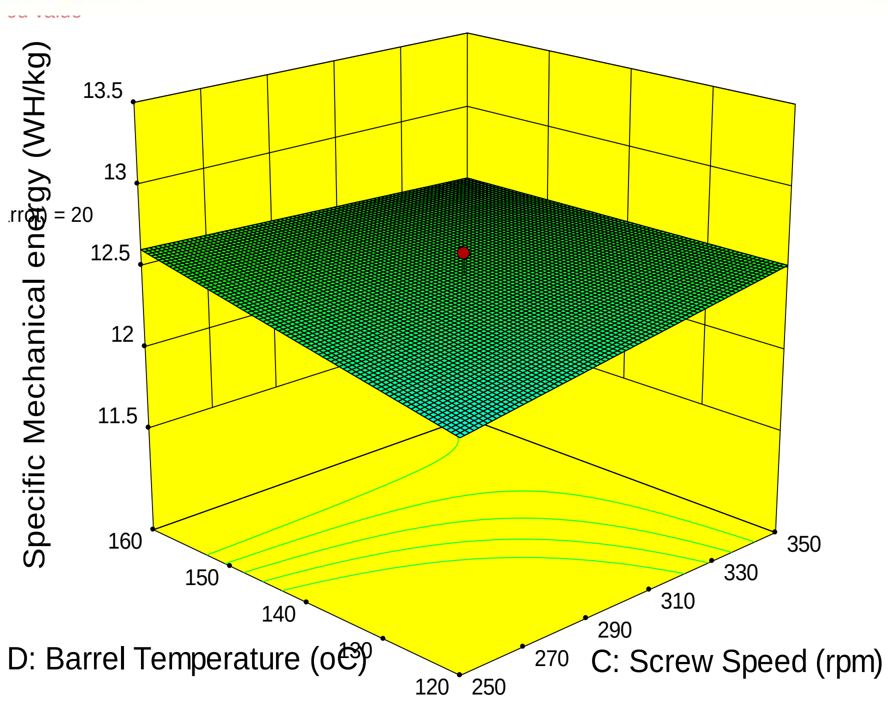


figure .Effect of barrel temperature and screw sped on specific mechanical energy

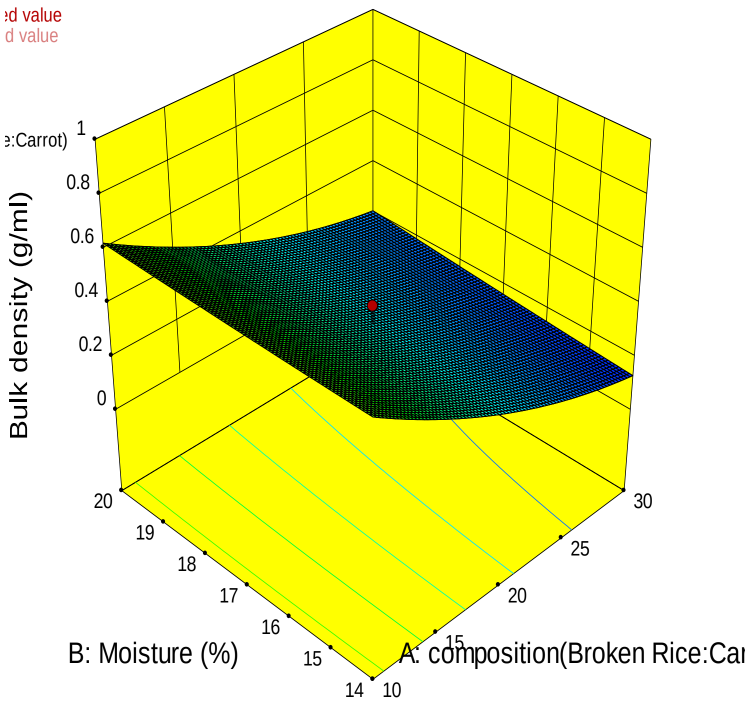


Figure a.Effect of moisture and composition on Bulk density

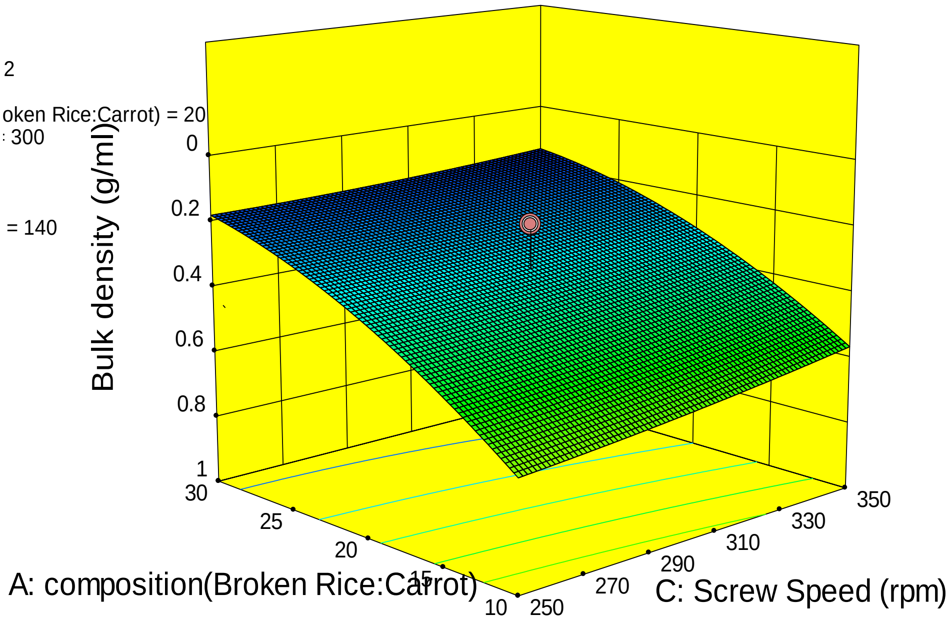


Figure b.Effect of composition and screw speed on bulk density

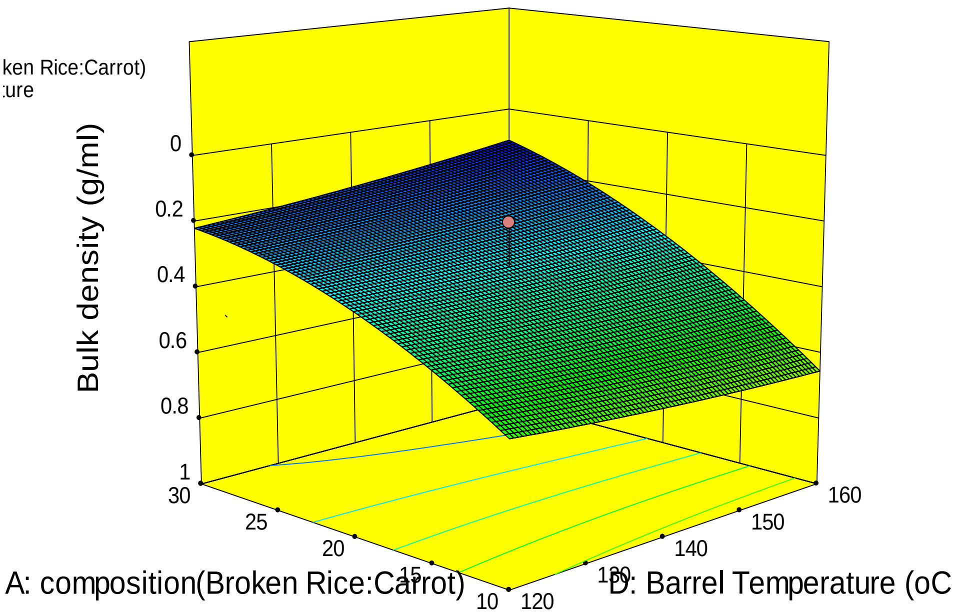
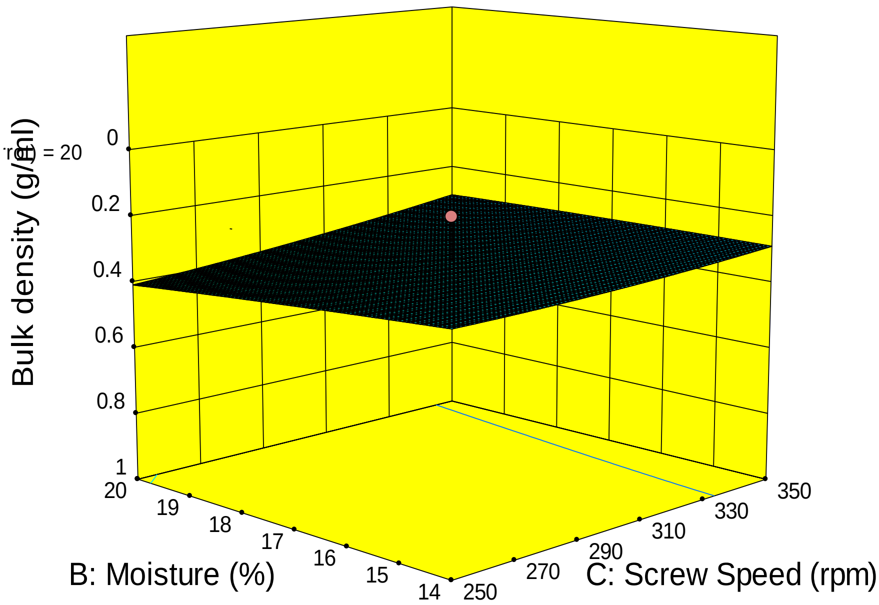


Figure c .Effect of composition and barrel temperature on bulk density



figur d.Effect of moisture and screw speed on bulk density

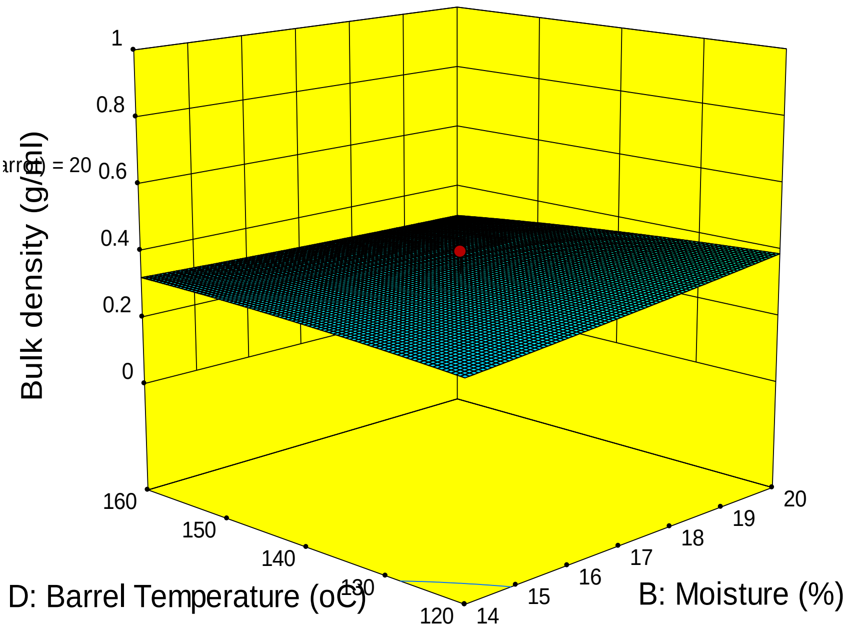


figure e.Effect of barrel temperature and moisture on bulk density

CONCLUSION

Response surface methodology was applied to experimental data in order to assess the effect of extrusion parameters .the results were analysed by multiple regression method which describes the effect of variables in the models derived. Graphical techniques in conection with RSM will help in locating operating conditions .

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