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Research Article

EFFECT OF BLENDING LITTLE MILLET WITH DEFATTED SOY FLOUR ON PHYSICAL PROPERTIES OF EXTRUDED

VASURE ANTIM, TIWARI V.K. AND WAKDE DEVISH

College of Agricultural Engineering, Jawaharlal Nehru Agricultural University, Krishinagar, Adhartal, Jabalpur, 482004, Madhya Pradesh
*Corresponding Author: Email-ksbhargav@rediffmail.com

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Abstract- This study was conducted on the effect of processing parameters i.e. moisture content of feed (8, 10, 12, 14, and 16 %) and blend ratio of little millet: defatted soy flour (60:40, 70:30, 80:20, 90:10, and 100:00) and operational parameters of extruder i.e. barrel temperature (60, 80, 100, 120, and 140° C), screw speed (60,80, 100, 120 and 140 rpm) and die head temperature (80, 100, 120, 140 and 160° C) on physical properties of extrudate (moisture content of extrudate, bulk density, specific length and sectional expansion index). It was found the moisture content of the extruded increases with increase in moisture content of feed and decreases with increase in the proportion of defatted soy flour in blend. As the feed moisture content increased, the value of sectional expansion index also increases. It was also observed that with increase in the die head temperature, the specific length of extruded also increased. The bulk density decreases with the increase in moisture content and increase in proportion of defatted soy flour.

Keywords- Little Millet, Defatted Soy Flour, Extruded and Blending.

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Introduction

Little millet known as kutki in hindi is grown in limited area as poor men's crop capable of withstanding both drought and water logging. It is generally grown on hills under shifting cultivation. Like other millets it is grown in *kharif* season. Millets grains rich in fiber, protein and minerals help manage diabetes, blood pressure, constipation and obesity [1]. Controlled gelatinized, extruded & flattened millet flakes, flavored with dark chocolate for taste, low pressure food with long with shelf life of six months. It has high satiety value, easy to carry, ready to eat, crunchy breakfast snack for all age groups. The kutaki millets contains 69% carbohydrates, 8.2% protein, 6.94% fibre, 3.37% fat, 2.89% minerals, at 12.6% moisture and just 335 calories/ 100 [2] and per 100 gm 3.3g ash, 35 mg calcium, 1.7 mg iron, 0.15 mg thiamin, 0-09 g riboflavin and 2 mg niacin at 12% moisture [3]. Defatted soy flour is high protein, low fat and a simplest form of soy protein. The protein content of the flour is 50-52%, much higher than the flour of other grains. The defatted soy flour is the by-product of oil industry in solvent extraction methods and available in abundance in Madhya Pradesh. Soybean, the first vegetable proteinaceous feed material was used for making protein rich extruded food [4]. In order to utilize, the good quality body building protein of these by-products it was thought of to blend the flour of these by products in different proportions with kutki flour and to identify various operating parameters of food extruded that can yield an acceptable, tasty and nutritious ready to eat extruded snack. [5] reported development of a highly acceptable extruded snack products containing soy protein, and evaluated the influence of soy protein type, soy level, and moisture content. To address the problem of malnutrition in tribal area, the enriched protein extruded may fulfill the nutrient requirement of children and women. In this context, the present study is under taken to study the effect of blending little millet with defatted soy flour on physical properties of extruded.

MaterialsandMethods

for the study little millet was procured from the KVK Dindori and defatted soy flour market. Little millet were thoroughly cleaned and graded by screen cleaner then it was dehusk by modified inclined energy sheller. After that it was grounded in a khammer mill to reduce the size into final particles to be used for preparing blend ratios. The required quantity of the obtained kutki flour was passed through 40 ASTM mesh size to obtain uniform size of particles. The Defatted Soy Flour was purchased directly from market. Little millet flour prepared by grinding in the hammer mill and defatted soy flour were blended in following ratio 60:40, 70:30, 80:20, 90:10 and 100:00 respectively. The moisture content of the flour of different blend ratio was measured by standard oven drying method. The moisture contain of the blends were brought to the desired moisture content levels by addition/removal were so as to get to the desired level of 8, 10, 12, 14, and 16% (wb) as planned in the experiment. The calculated amount of water plus an addition amount of 10% of calculated water was added to supplement the evaporation losses during mixing and conditioning, tempering of samples was done by keeping the moistened samples for 24 hours at room temperature so as to get uniform distribution of moisture throughout the mass of blend. In the present study, the effect of processing parameters i.e. moisture content of feed (8, 10, 12, 14, and 16 %) and blend ratio of little millet : defatted soy flour (60:40, 70:30, 80:20, 90:10, and 100:00) and operational parameters of extruder i.e. barrel temperature (60, 80, 100, 120, and 140o C), screw speed (60,80, 100, 120 and 140 rpm) and die head temperature (80, 100, 120, 140 and 160o C) on physical properties of extrudate (moisture content of extrudate, bulk density, specific length and sectional expansion index). The responses were analyzed by response surface methodology (RSM) using central composite rotatable design (CCRD).

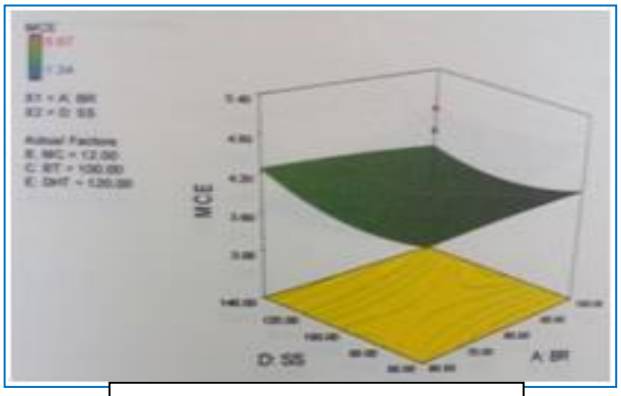
The responses were selected to optimize ready to eat snakes of blends of little millet and defatted soy flour on the basis of their acceptable quality.

Results and Discussions

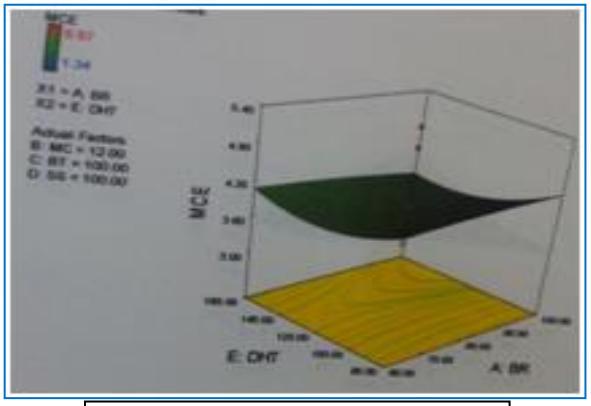
The effect of five independent variables like moisture content of feed, blend ratio, barrel temperature, die heat temperature and screw speed on physical parameters (moisture content of extrudate, bulk density, specific length and sectional expansion index), and textural properties (crispness) of extruded have been measured using developing the response surface through CCRD of blend of kutki and defatted soy flour extruded. The generated data were analyzed through CCRD having RSM and their interpretations were presented. The adequacy of the model was performed using the coefficient of determination (R2) and fisher's F-test through ANOVA table. Also various response surface graphs were drown on the basis of generated data to observe the effect of independent variables on dependent variable.

Moisture content of extruded- The polynomial model in actual terms generated by multiple regression analysis using CCRD and fitting of second degree polynomial equation for representative response surface of data between moisture content of extruded (MCE) versus actual values of feed moisture content (MC), blend ration (BR), barrel temperature (BT), die head temperature (DHT), and screw speed (SS), resulted the development of following model;

MCE= 14.026 + 0.12 x BR – 0.91 x MC + 0.09 x BT -0.19 x SS – 0.14 x DHT + 0.015 x BR x MC – 2.29E-003 x BR x BT – 4.15E-004 x BR x SS – 4.15E-004 x BR x DHT + 5.2E-003 MC x BT – 4.17E-003 x MC x SS + 2.07E-003x MC x DHT + 1.03E-003 x BT x SS – 6.23E-004 x BT x DHT + 5.20E-004 x SS x DHT – 3.07E–004 x BR2 – 7.38E-003 x MC2 + 2.61E-005 x BT2 + 5.51E-004 x SS2 + 6.51E-004 x DHT2 The fitted model has showed the strong association between variable under study with the response variable due to high value of R2 (0.78). [6] also found same result in lentil based extruded product. This shows second order model was adequate in describing the MCE of sextruded. The moisture content of extruded increases with increase moisture content of feed and the rate of increase is almost uniform with increase the moisture content also the moisture content decreases with increase in the proportion of defatted soy flour in blend. The increase in the moisture content of extruded at higher moisture values is chiefly because as moisture level in feed increase increases the amount of moisture retained in extruded also increase as a linear function, whereas the decrease in moisture content of extruded with increase in proportion of defatted soy flour may be because defatted soy flour has more amount of gluten than that of kutki powder and gluten has the more capacity to retain water even at higher temperature.



Effect of BR & SS on MC of extruded



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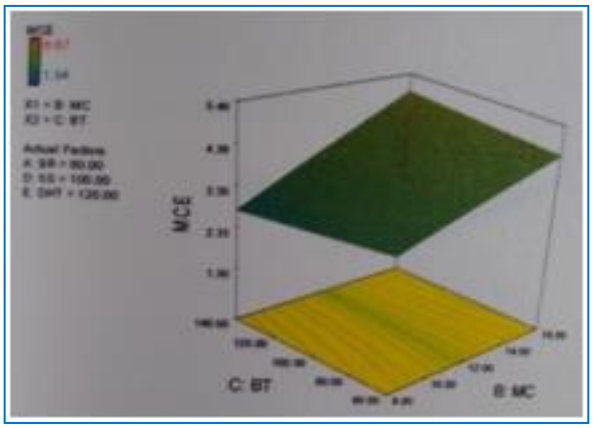

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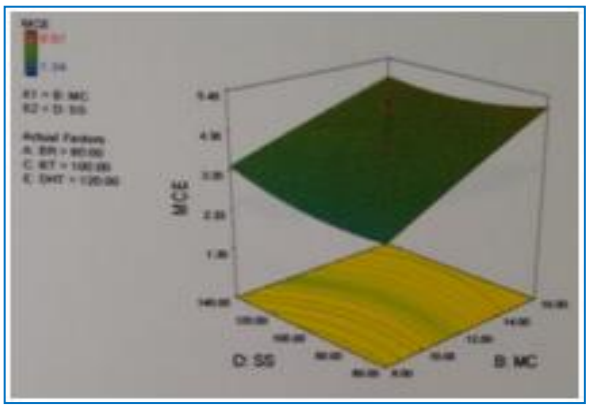

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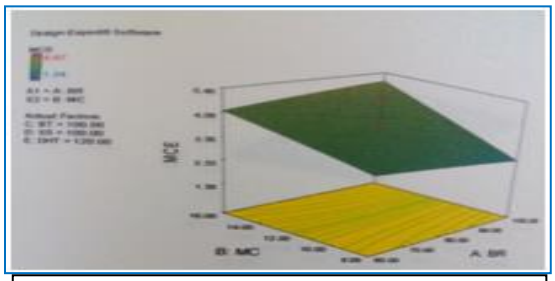
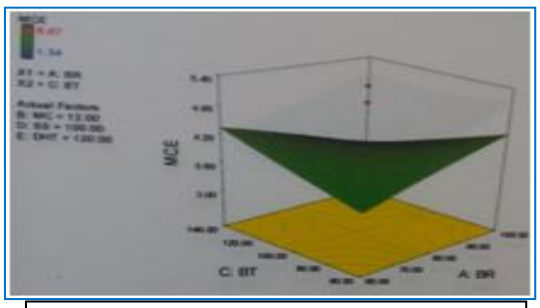
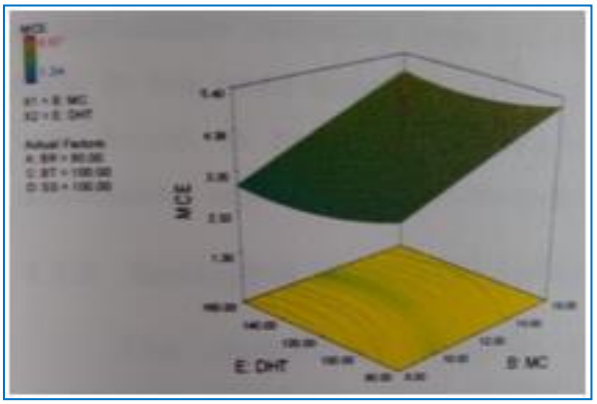


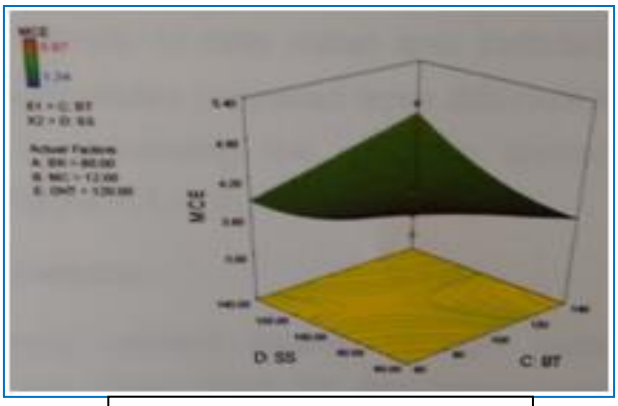
Effect of BR & MC of feed on MC of extruded



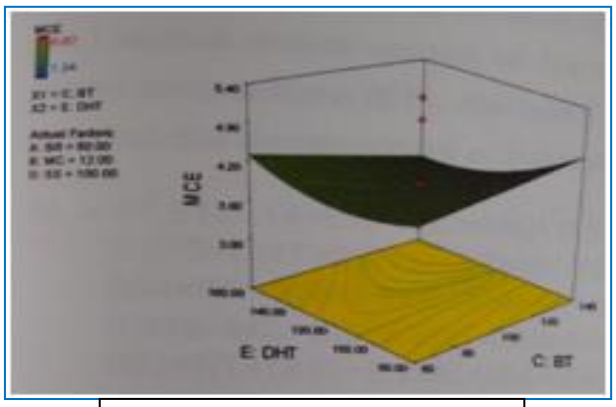
Effect of BT & BR on MC of extruded



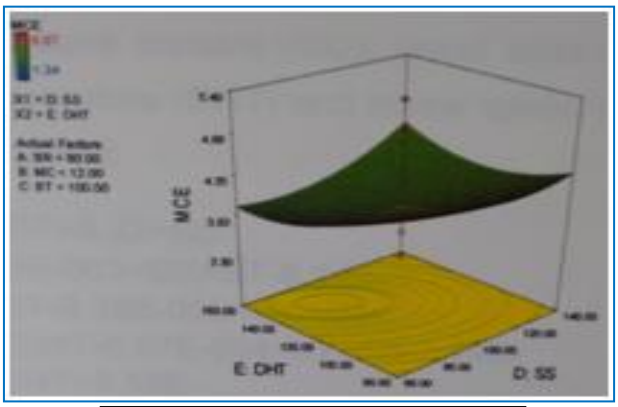
Effect of DHT & MC of feed on MC of extruded



Effect of BT & SS on MC of extruded



Effect of BT & DHT on MC of extruded



Effect of SS & DHT on MC of extruded

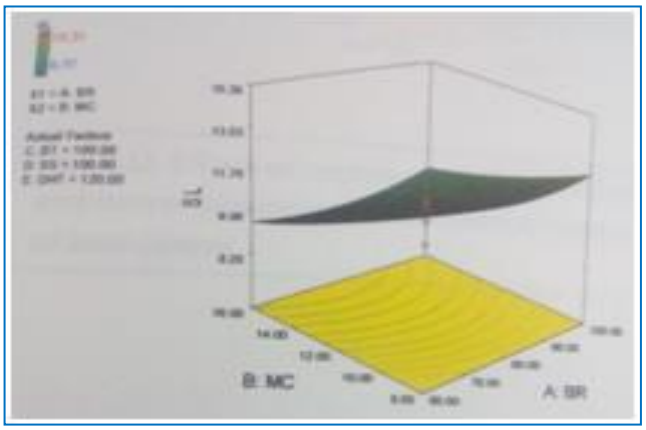
Anova for qradratic model of response surface generated by CCRD for moisture content of extruded of prepared from different blends of little millet and defatted soy flour was found highly significant in governing the moisture content of extruded.

Specific Length of Extruded

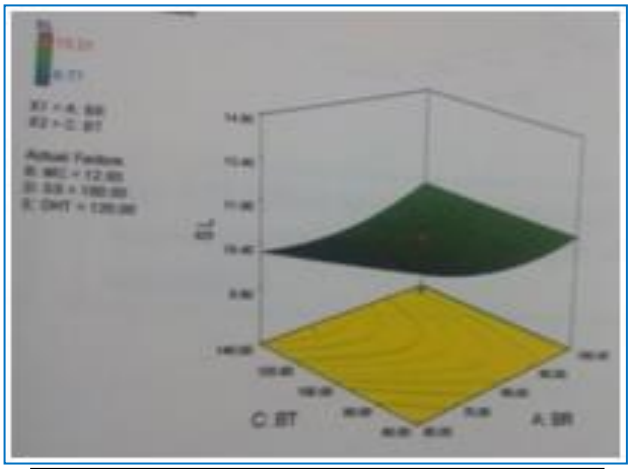
The polynomial model generated by multiple regression analysis using CCRD and fitting of second degree polynomial equation for representative response surface of data between mass flow rate extruded (SL) versus actual value of feed moisture content (MC), blend ratio (BR), barrel temperature (BT), die head temperature (DHT) and screw speed (SS), resulted the development of following model

$SL = 51.81 - 1.14 \times BR - 1.52 \times MC + 0.23 \times BT + 0.22 \times SS - 0.073 \times DHT + 0.011 \times BR \times MC + 2.05E\text{-}003 \times BR \times BT - 8.84E\text{-}004 \times BR \times SS + 3.84E\text{-}004 \times BR \times DHT + 8.39E\text{-}003\ MC \times BT - 0.019 \times MC \times SS + 8.70E\text{-}003x\ MC \times DHT - 6.50E\text{-}004 \times BT \times SS - 2.14E\text{-}003 \times BT \times DHT + 6.26E\text{-}004 \times SS \times DHT + 5.33E\text{–}003 \times BR^2 + 0.067 \times MC^2 + 4.54 \times BT^2 + 2.45E\text{-}004 \times SS^2 + 4.23E\text{-}004 \times DHT^2$

The fitted model has shows the strong association between variable under study with the response variable due to high value of R^2 (0.78). This shows second order model was adequate in describing the SL of extruded. The movements of contours are towards the higher value of moisture content increased specific length was decreased simultaneously. Also it was observed that with increase in die head temperature, the specific length of extruded also increased. The results of analysis of variances (ANOVA) for quadratic model of response surface generated by CCRD for specific length with interaction of barrel temperature and die head temperature was found nearly significant and as well as moisture content of feed is highly significant. It was also found moisture content plays an important role in addition to interaction of barrel temperature and die head temperature.



Effect of MC & BR on SL of extruded



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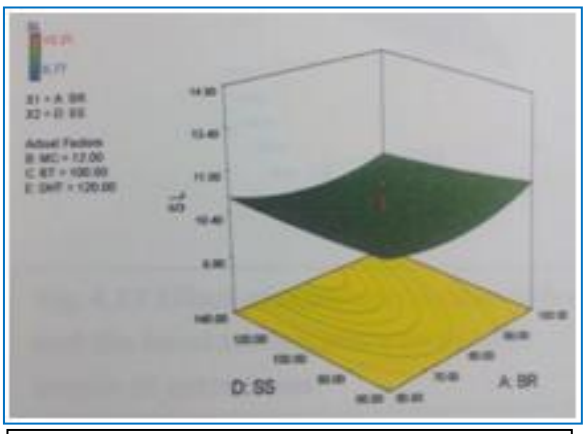
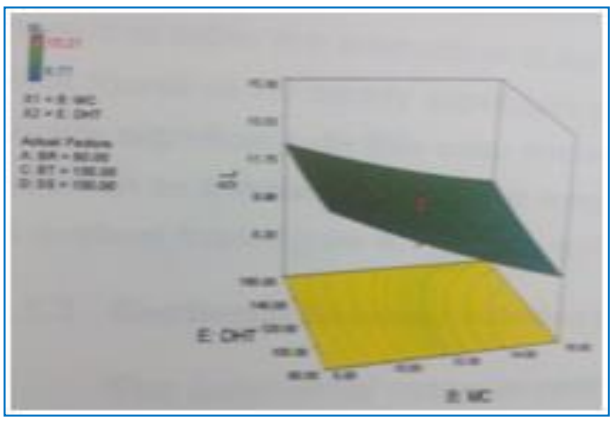
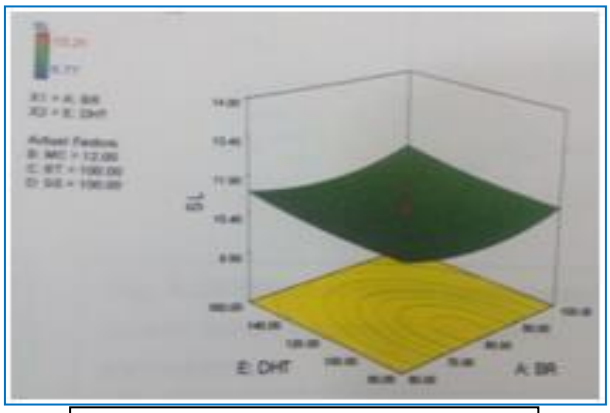


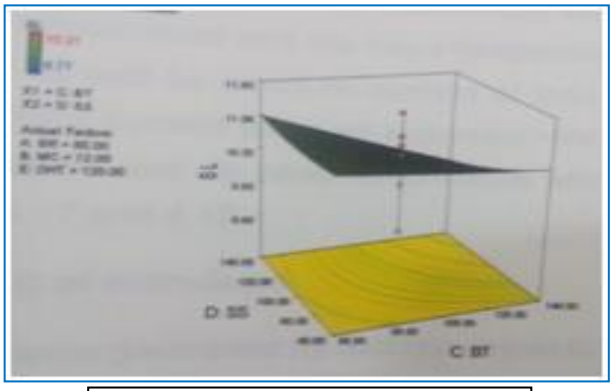
Effect of SS & BR on SL of extruded



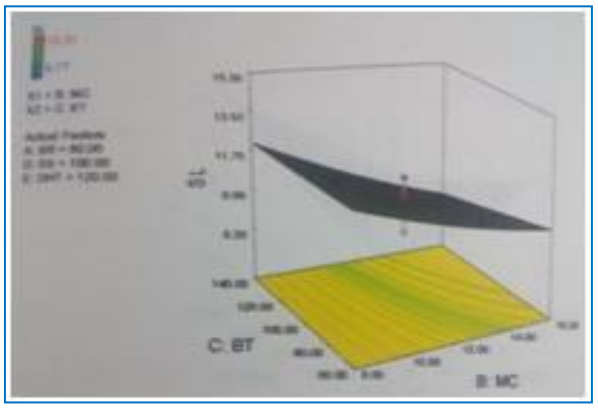
Effect of MC & DHT on SL of extruded



Effect of DHT & BR on SL of extruded



Effect of SS & BT on SL of extruded



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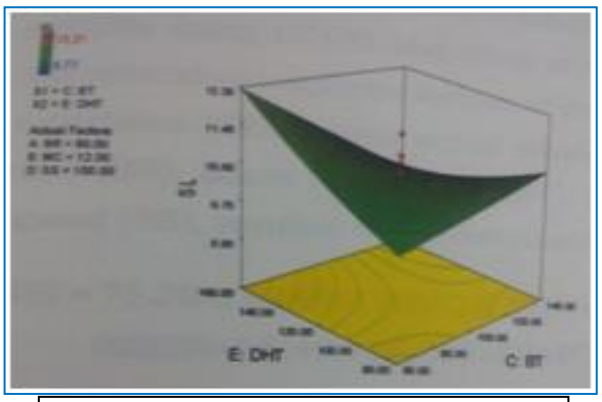
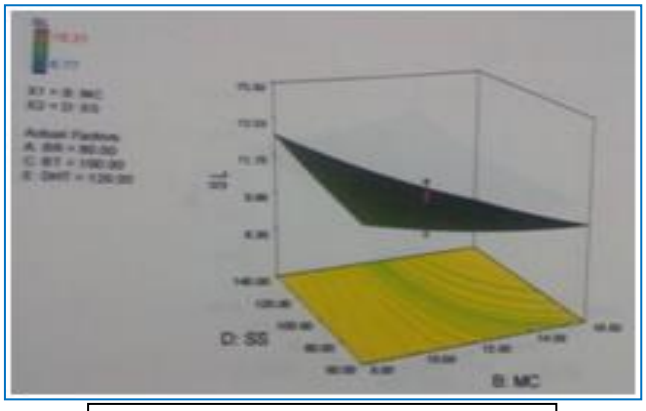
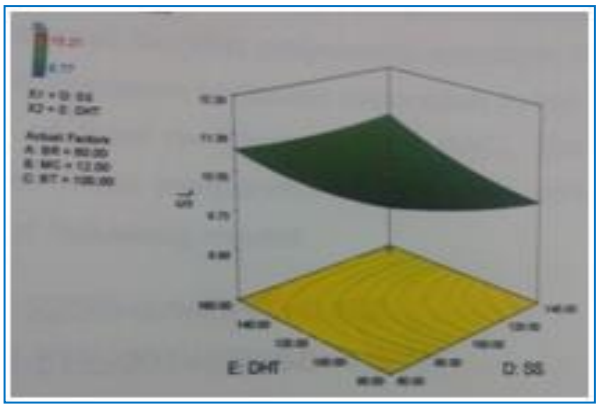


Effect of DHT & BT on SL of extruded



Effect of MC & SS on SL of extruded

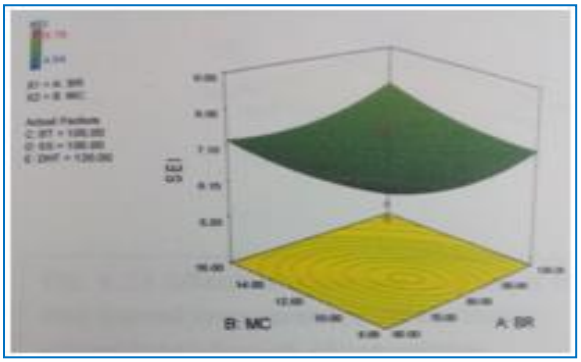


Effect of DHT & SS on SL of extruded

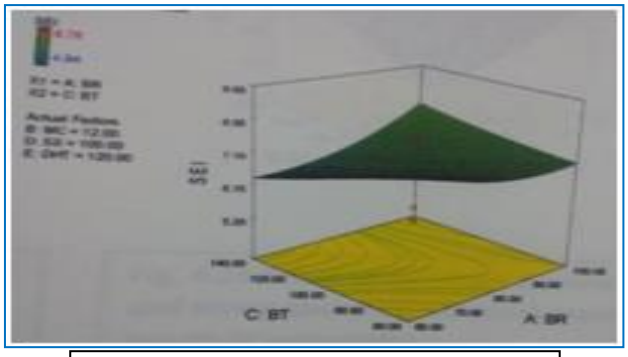
Sectional Expansion Index (SEI) of extruded

The polynomial model generated by regression analysis between sectional expansion index of extruded (SEI) versus actual value of feed moisture content (MC), blend ratio (BR), barrel temperature (BT), die head temperature (DHT) and screw speed (SS).

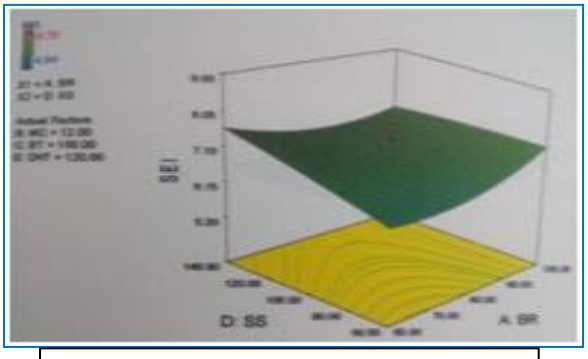
SEI= 75.79 - 0.84 x BR – 3.26 x MC - 0.37 x BT +0.22 x SS – 0.14 x DHT + 9.46E-003 x BR x MC + 2.75E-003 x BR x BT – 1.57E-003 x BR x SS + 4.34E-004 x BR x DHT + 0.018x MC x BT – 0.012 x MC x SS + 6.64E-003x MC x DHT + 9.92E-004 x BT x SS – 1.66E-003 x BT x DHT - 1.14E-004 x SS x DHT + 3.58E–003 x BR2 + 0.051 x MC2 + 1.58E-004 x BT2 - 1.00E-004 x SS2 + 8.86E-004 x DHT2 The fitted model has shows the strong association between variable under study with the response variable due to high value of R2 (0.73). This shows the second order model was adequate in describing the SEI of extruded. As the feed of the moisture content increased the value of sectional expansion index also increased and the increase in amount of defatted soy flour increases the sectional expansion index because in defatted soy flour increase the amount of kutki powder which have higher fiber content and increase in fiber content reduces the sectional expansion of extruded. The result of analysis of variance (ANOVA) for sectional expansion index of extruded, interaction of barrel temperature with moisture content and die head temperature was found significant.



Effect of MC & BR on SEI of extruded



Effect of BT & BR on SEI of extruded



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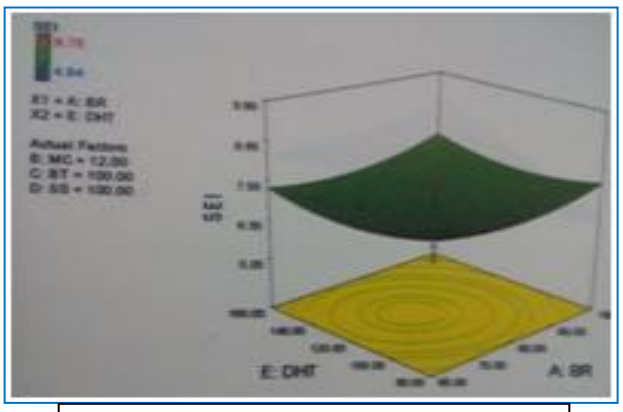
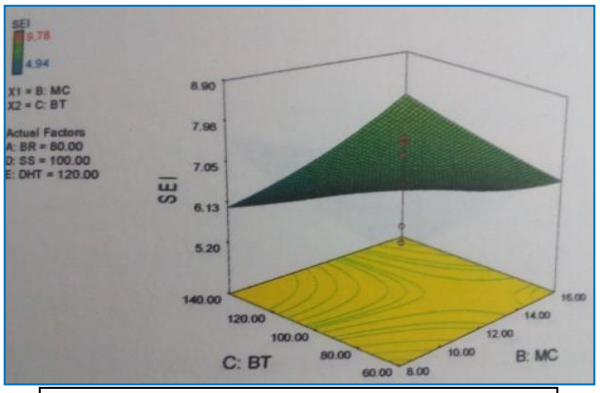
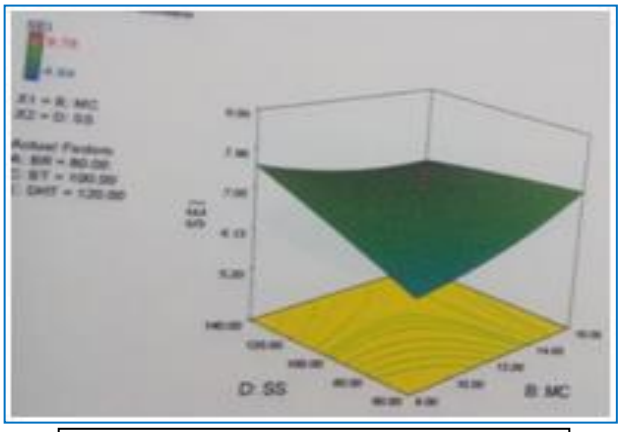


Effect of DHT & BR on SL of extruded



Effect of BT & MC on SL of extruded



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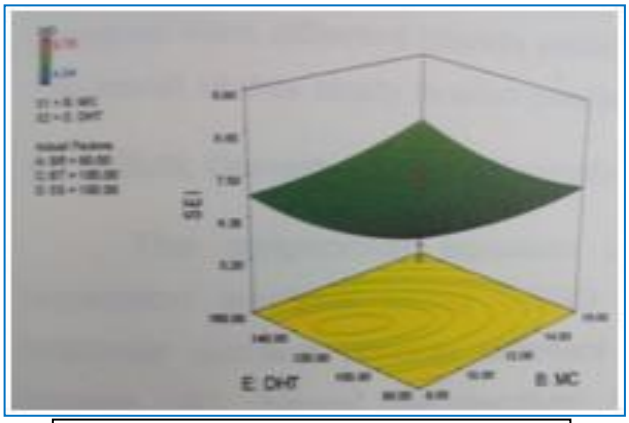
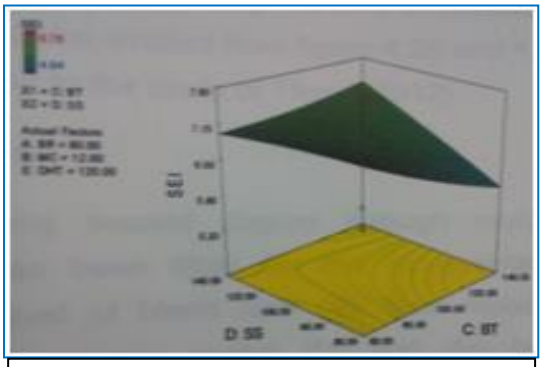
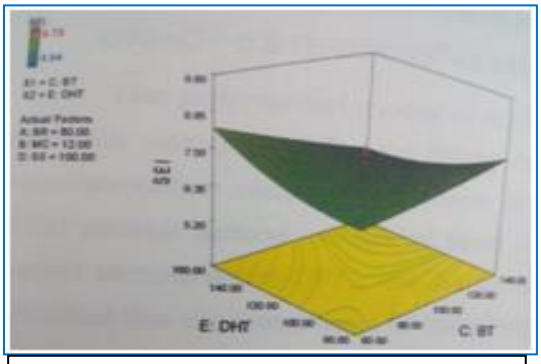


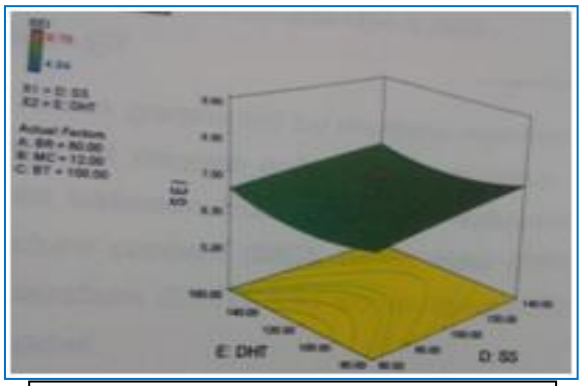
Effect of MC & DHT on SEI of extruded



Effect of SS & BT on SEI of extruded



Effect of DHT & BT on SEI of extruded



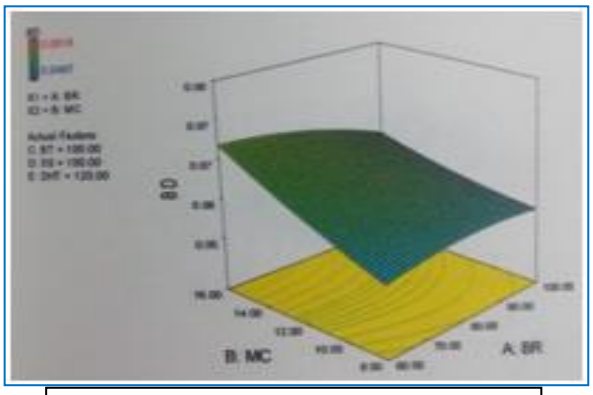
Effect of DHT & SS on SEI of extruded

Bulk Density

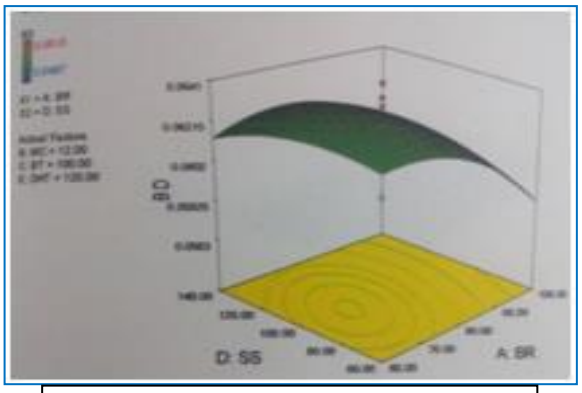
The model generated by multiple regression analysis between bulk density versus actual value of feed moisture content (MC), blend ratio (BR), barrel temperature (BT), die head temperature (DHT) and screw speed (SS).

BD= -0.01 + 3.67E-003 x BR – 2.61E-003 x MC + 1.05E-003 x BT -1.04E-003 x SS – 1.16E-003 x DHT - 1.01E-004 x BR x MC - 1.25E-005 x BR x BT + 3.18E-006 x BR x SS + 4.50E-006 x BR x DHT - 1.87E-006x MC x BT + 8.43E-005 x MC x SS - 3.12E-007x MC x DHT + 9.37E-008 x BT x SS + 4.93E-006 x BT x DHT + 1.00E-006 x SS x DHT - 1.36E–005 x BR2 + 2.10 E-004x MC2 - 2.73E-006 x BT2 - 1.70E-006 x SS2 + 6.70E-007 x DHT2

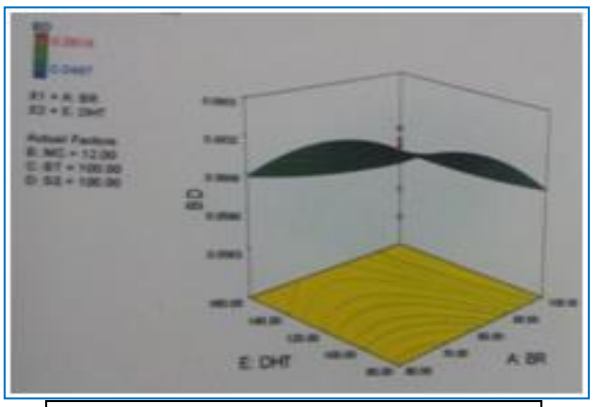
The fitted model has shown the strong association between variable under study with the response variable due to high value of R2 (0.84). The bulk density decreases with the increase in moisture content and increase in proportion of defatted soy flour and with increase in moisture content the mass per unit volume of extruded increase, which is ultimately responsible for increase in bulk density. The result of analysis of variance (ANOVA) for bulk density, interaction of moisture content and screw speed was found significant of 5% level. It indicates that the interaction between MC and SS plays an important role in governing the character of bulk density which is required for extruded of different blends. This result found to more consistent with the result given by [7] and [8]



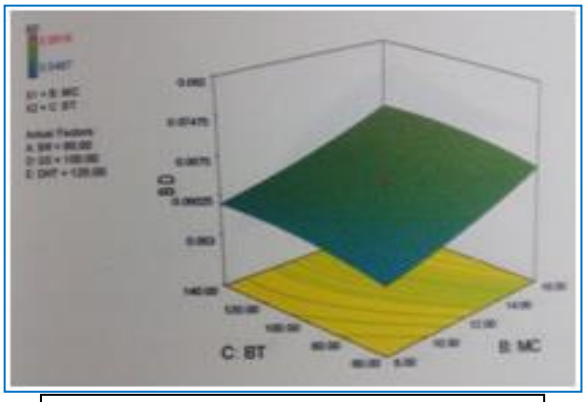
Effect of MC & BR on BD of extruded



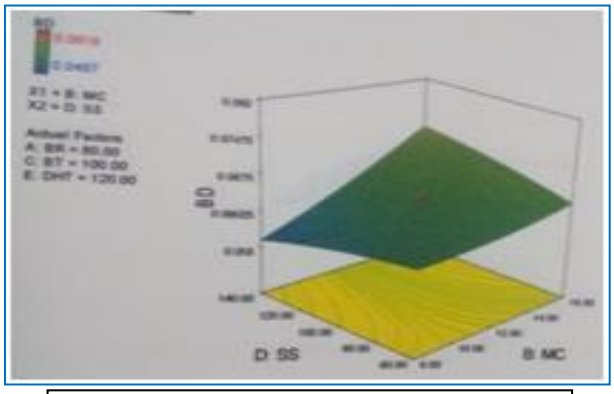
Effect of SS & BR on BD of extruded



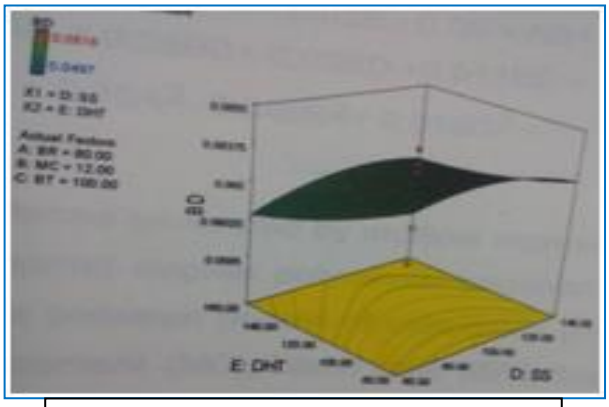
Effect of DHT & BR on BD of extruded



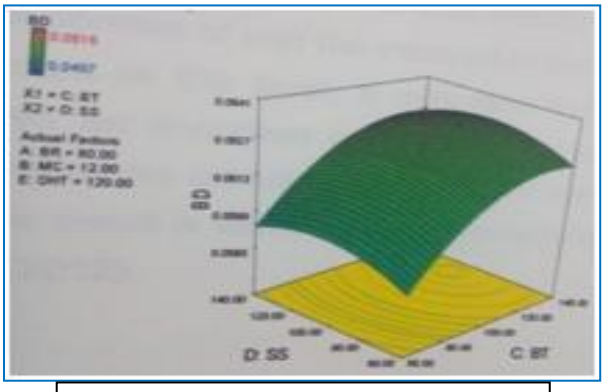
Effect of BT & MC on BD of extruded



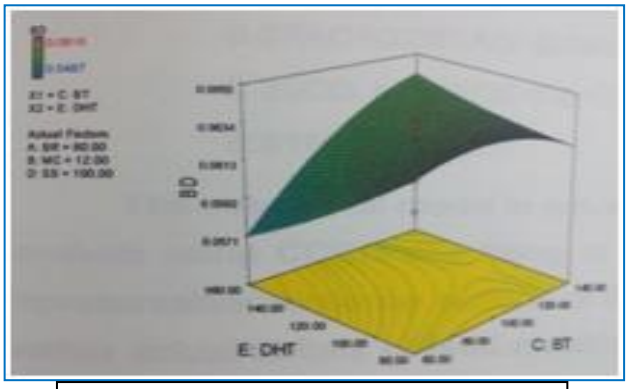
Effect of SS & MC on BD of extruded



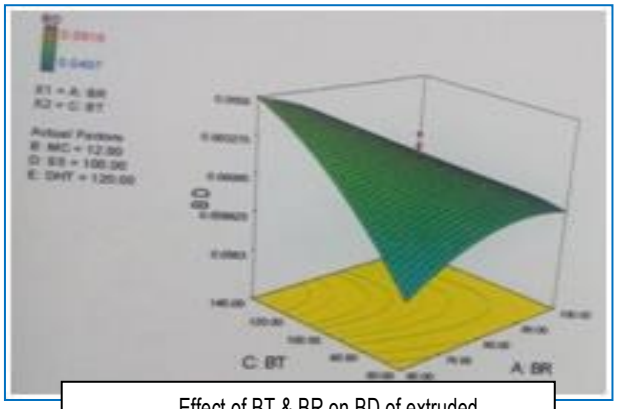
Effect of SS & DHT on BD of extruded



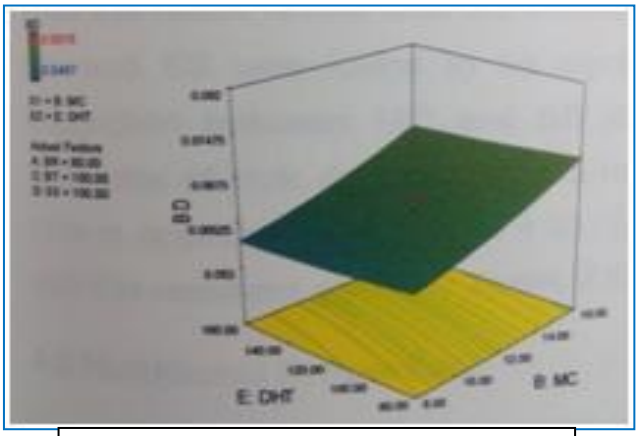
Effect of SS & BT on BD of extruded



Effect of DHT & BT on BD of extruded



Effect of BT & BR on BD of extruded



Effect of DHT & MC on BD of extruded

Conclusions

It was concluded that the moisture content of the extruded increases with increase in moisture content of feed and decreases with increase in the proportion of defatted soy flour in blend. As the feed moisture content increased the value of sectional expansion index also increases. It was also observed that with increase in the die head temperature, the specific length of extruded also increased. The bulk density decreases with the increase in moisture content and increase in proportion of defatted soy flour.

Conflict of Interest: None declared

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