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Assessment of the Effect of Processing Parameter and Particle Size on Functional Features of Turmeric Flour

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Abstract:- The effect on functional qualities of the processing parameter and particle size describes the changes in ingredient behaviour during preparation and cooking and how they affect finishing foods as to how they feel, look and taste. Functional features are: foaming capacity, foaming stability, swelling index, water absorption capacity, oil absorption capacity, gelatinization temperature, least gelatinization temperature, emulsion capacity, emulsion stability. The functional characteristics of food and flours are affected by the components (meal) and structures of the food additives that are added to the food. Each ingredient in a dish has a distinct role, which typically affects the food's functional property. The effect of the temperature study demonstrates that the effects for all swelling index, water absorption capacity, minimum gelatinate, emulsion capacity of P-value are important, all the characteristics expected in the study are affected by the particulate size. The high boundary area at which each property was determined using an interplay of two parameters (temperature and particle size). The limit of high spraying power was 55 oC and Particle size lower than 240 µm, the spraying stability was nonlinear and the swelling index interaction effect was primarily defined by the particle size, 240 µm below the test temperature, which gives the high-powered region an oil absorption capacity targets area of 330 µm higher with the drying temperature. of 40 -50 ^{o}C , The higher drying temperature was affected by the drying temperature, the lower the gel temperature with ranges from 82 to 98 °C, the activity of emulsion of the turmeric flour since its interactions exhibit the variables, the higher the drying temperature the binding capacity is improved. Turmeric flour has a wonderful quality which makes the flour sweet as a supplement for the bakery product with negative complications during the manufacturing procedure.

***Keyword**:- Dimensional, Properties, Responses, Stability, Turmeric.*

I. INTRODUCTION

Turmeric (Curcuma longa L.) is a major economic crop grown for its subterranean rhizomes that have a widespread application in medication, cosmetics, condiments, curry products and on religious and propitious events. Turmeric is found in South American countries and is native to Indian countries. Because of its biological activity, it is traditionally employed in indigenous herbal remedies. Turmeric is utilized in industry for special foods and children's foods because of its easy digestion. In addition to the usage in traditional medicine for injury treatment, turmeric has long been known in India and many other nations as an essential food supplier (Panneerselvam, 2007).

Turmeric has both primary and secondary rhizomes, which are accessible as globular, slightly conical, hemispherical and visible. The physical and functional features include length, width, bulk density, true density, porosities, particle size analyses, pH and water absorption capability (Balasubramanian and Viswanathan, 2010). It is also called "Indian saffron," because this was often used as a replacement for the expensive spice of saffron (Oladimeji *et al.*,2019). Turmeric is grown in Nigeria in house garden areas in around nineteen (19) states, where the names "Osun," "Ata-Ile" and different names serve varied functions. It is used for malaria and circumcision in Ebonyi and Enugu states. People of the State of Benue use fresh currant to label yams whereas Kastina State inhabitants use it for decoration. Ekiti State uses turmeric rhizome plants for curing ailments like malaria, thyphoid and yellow fever (Olojede, 2005). In folk medicine, turmeric rhizomes have been used in inflammatory, carcinogenic, diabetic, abdominal, cholesterol-induced, wound and as a blood purifier to cure inflammation. Ikpeama etal., (2014) studied the nutrition of turmeric with 8.92% moisture, 2.85% ash, 4.60% crude fiber, 6.85% fat, 9.40% raw protein and 67.38% carbon dioxide. The nutritional content of tourmeric was explored. Powdered rhizomes also found to contain 70%-76 percent curcumin, Gopinathan *et al.*,(2011). A

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powerful antioxidant responsible for the bioactivities of turmeric is curcumin, a yellow colored active component. Curcumin also includes critical substances, e.g. vitamin C, beta-carotene, polyphenol, fatty acids, and essential oil. When it is dried and ground, the rhizome of turmeric can be used in recipes as a spice ingredient. The addition of turmeric in the cooking process gives the meal a characteristic yellow colour. Powder turmeric was also utilized in cosmetics and pharmaceuticals.

The quality of any agricultural product is dependent on the material's intrinsic quality and management during its processing. The quality of turmeric powder can also be determined in the same vein through the processing procedures. Turmeric rhizomes during the production process are subjected to a number of circumstances that can harm nutritionals. Usually they are cooked and dried prior to use. The slicing of the rhizome, sun drying and grinding are other traditional curing processes. The color of the products resulting in a product shrink, which leads to the final unappealing product, was reportedly affected by sun-drying. Before reducing nutritional losses, blanching and application of chemical therapies were used. In India, rhizome is commonly boiled before dehydration in alkaline media. For any detailed study, design or operation of milers, the functional qualities of turmeric plants are vital. Turmeric has uneven shapes and sizes most often and has proven to cause harm to the sample and also wastage during pretreatment such as skin removal. The physical and functional qualities of the rhizome plant are necessary in order to improve the operations of current millers by means of an upgraded combustion system or to design a new system along (Athmaselvi and Varadharaj, 2002). The physical qualities of a turmeric rhizome plant assist to develop suitable machinery which will reduce losses of necessary and valuable components (peels and stem bell) that can be beneficial for the health (functional properties) and which are also used as a replacement for fake pharmaceuticals.

II. MATERIALS AND METHOD

Sample collection and Preparation: The turmeric rhizome sample was collected from The National Root Crops Research Institute, Substation Nyanya, Abuja. The turmeric rhizome plant was properly cleansed for a minute under running water in order to remove undesirable elements. The drained sample was cut and dried using the I-Optimal design of twenty (20) experimental rounds in reference to the response surface methods. The dry sample was milled with a cyclonic milling machine and graded to distinct particle size for the responses.

THE RESPONSES DETERMINED

Foaming capacity and stability

Mustapha et al. (2015) describes the method to evaluate the foam capacity of samples, using different amendments. The speed employed was 160 rpm for 10 minutes during the homogenization. Sample foam capacity is then determined using the following formula.

$$:Foam\ capacity(\%) = \frac{volume\ of\ foam\ AW - volume\ of\ foam\ BW}{volume\ of\ foam\ BW} \times 100 \qquad (1)$$

Where A = volume before homogenization (mL), B = volume after homogenization (mL).
Foam stability of samples then calculated by using the formula as follow:

$$\text{FS}= \frac{(foam\ volume\ after\ time\ t \times 100)}{Initial\ foam\ volume} \qquad (2)$$

Swelling Capacity and Starch Solubility Index

The Anyasi et al. (2017) technique was used to assess the flour samples swelling capacity and solubility index by blending around one g of flour into the centrifugal tube with ten mL of distilled water and heating it to 80oC for 30 minutes under steady agitation. Room temperature removed the tubes and cooled them. When the samples were cooled, they were sampled at 2200 rpm for 15 minutes. It decanted the supernatant and determined the weight of the purée. The supernatant derived from the swelling power was discounted for the solubility index in a pre-weighted evaporation dish and dried and calculated to the constant weight of the oven.

Water Absorption Capacity

Water absorption and water-binding capacities were determined using AOAC (2006) methods.

Oil Absorption Capacity

The method used to determine Oil absorption capacity of samples is as described by Adebowale *et al.* (2005).

Gelatinization Properties

Gelatinization temperature was determined by Shinde (2001).

Emulsion Capacity

The method used to determine the emulsion capacity of samples is as described by Mustapha et al. (2015)

Emulsion Properties

The emulsifying capacity (EC) of each sample has been assessed by titrating with maize oil to the emulsion rupture point in 100 mL (1% w/v/w) aqueous dispersion at the pH values of 3,0, 4,5 and 6,0, 7,5 and 9.0. (Naczk *et al.*,1985). As ml oil emulsified by a dry sample of 1 g, emulsification capacity (EC) was indicated. In the periods of 15, 30, 50 min, 1, 2, 3, 24, 48 hours, ES emulsion stability (25 ± 2°C) was measured (Suresh *et al.*,2015 ; Dipak and Kumar, 1986).

III. DISCUSSION OF RESULT

The physico-chemical characteristics of foods are vital, imitating the multiple facets of the links between food molecular conformants, structures and physico-chemical properties of biomaterial components with nature and conditions of their environment (Awuchi, *et al.*,2019).

Foaming Capacity: Foaming capacity and stability are mainly based on the interfacial proteins coating that preserves air bubble suspension and slows the process of

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coalescence (Cousminer, 2017; Akintayo *et al.*,1999). Surface response and contour outlines (Figs.1. and 2) with foaming capacity to attain the maximum temperature and particle size above 55 0 C and 150 mm of a maximum value of 22.7403%, respectively. With increasing temperature and particle size, the amount of spray is decreasing While the lower temperature foaming capacity (40 o C), for particle sizes between 420 and 510, is quite low. As shown in Fig. 2, the particle size had significant effect on foaming stability, which was also confirmed by ANOVA (F = 30.04; P-value = 0.003). At 40–50 ° C and at 330mm-510mm particulate size, the minimal limit level of response between 18 and 19,5073 percent. The sample was 3 mm in slice thickness. The temperature effect was significant at $p \leq 0.05$. for the two-factor interaction.

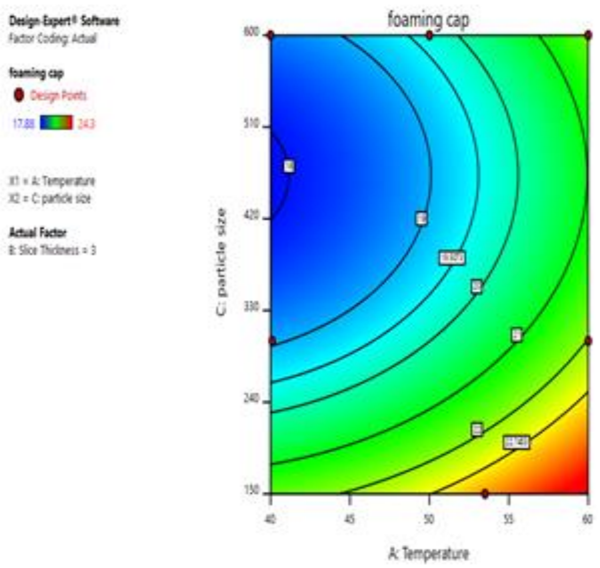


Figure 1: 2-dimensional plot of temperature and particle size of Foaming Capacity.

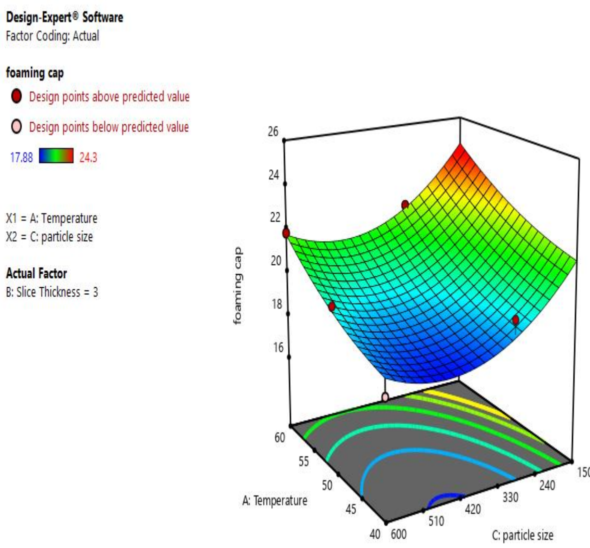
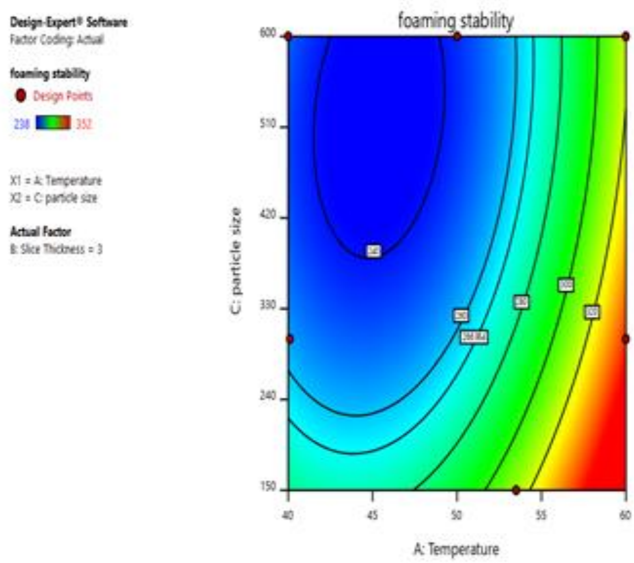


Fig. 2. : 3-dimensional plot of temperature and particle size of Foaming Capacity.

Foaming Stability: The foaming stability contour and surface plot assist experimenters to gain insight into the nature of the interaction between the two parameters (temperature and particle size) and the turmeric flour's response stability. The amount of partial protein denaturation is assigned. The foaming stability diminishes significantly as temperature increases and decreases with an increase in particle size and a variety of particle (150-600µm) sizes. As shown in Figures 3 and 4. For the complete 20 trial runs, the highest and minimal spum stability is 352% percent and 238 % percent. In addition, the fitted surface responds (Figure 4) in order to determine a direction to improve the process of foaming of the turmeric flour. The particles are used to analyze the maximum limits of 3mm at constant slice thickness, the two elements of temperature interaction at 50°C to 55°C and at particle sizes of 240 to 330 µm and the total particle size with foaming stability from 240 % to 266.95 %.



.Fig. 3: 2-dimensional plot of temperature and particle size of Foaming Stability

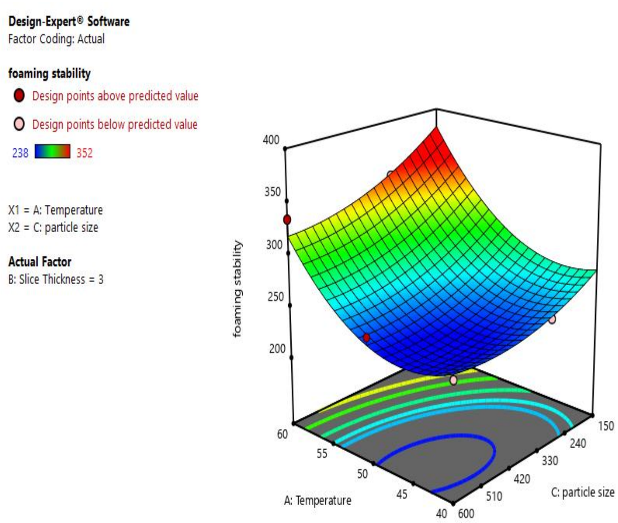


Fig. 4. : 3-dimensional plot of temperature and particle size of Foaming Stability.

Swelling Index: In various culinary goods such as bakery products, swelling capacity (index) is regarded as an eminence metric. The non-covalent binding of the molecules of the starch granules as well as the α-amylose and amylopectin ratio is an indication (Iwe *et al.*,2016). As the particle size grows at all experimental temperature levels, the response surface and two-dimension contour contours of the inflation index (Figure 5 and 6). At particles below 240µm at a temperature of 40 to 60 0 C, the highest value of 95 percent can be reached. At large particles of 240µm, the swelling index is relatively low. The particle size had no significant effect on swelling index, which was also confirmed by ANOVA (F = 17.77; P-value = 0.0018). The minimum boundary level on the response at range of 90% to 90.262 % was at all temperature and at particle size below 510mm to 150mm. the slice thickness of the sample was at 3mm. Temperature effect on the two-factor interaction was significant at p≤0.05.

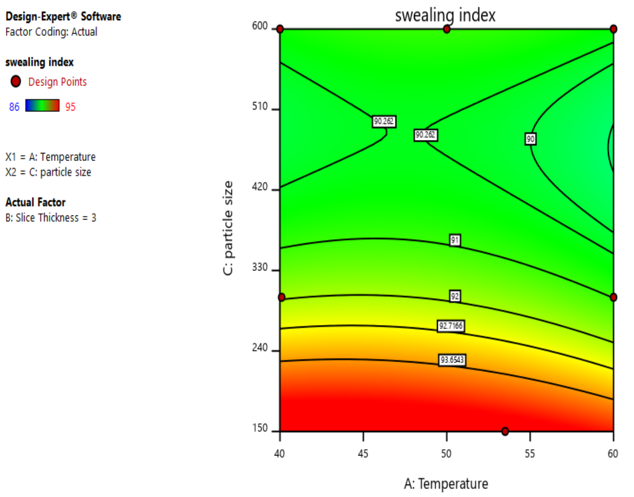


Fig. 5.: 2-dimensional plot of temperature and particle size of Swelling Index.

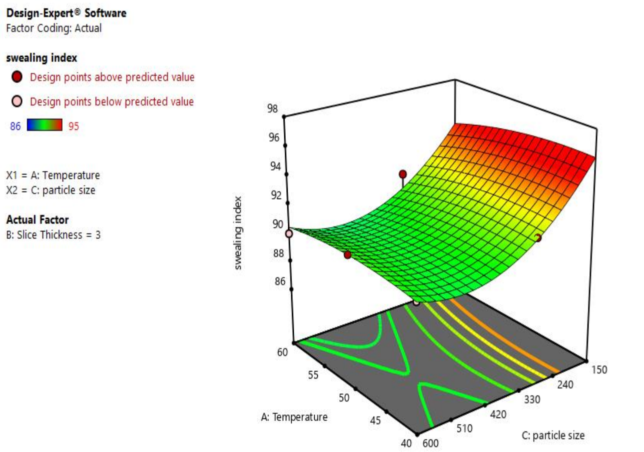


Fig. 6. : 3-dimensional plot of temperature and particle size on Swelling Index

Water Absorption Capacity (WAC): flour intake amount of moisture to obtain the desired uniformity and produce quality food. Before it becomes too sticky to process, it is the optimal water to be added in a pot. Excessive or very low water absorption might adversely influence food baking goods' quality (Awuchi, *et al.*,2019). The following parts assist pseudo-scientists to gain an idea of how the two parameters (temperature and particle size) are connected to the turmeric flour's response water absorption capacity. The water uptake is decreasing with an increase in the size of the particles and the varying temperature, as can be seen in figures 7 and 8. For trial runs the minimum and maximum water absorption capacity is 46 and 51%. Moreover, the fitted surface respond (Figure 8) to find a direction of potential enhancement for water absorption capacity process of the produced turmeric flours. The slicing thickness for the analysis at constant size 0f 3mm, the maximum boundary at which the two factors interaction of temperature at all point 40 to 60 °C and particle size of 150 -170µm with water absorption capacity greater than 52.20 % can be achieved. Particle size effect vary with much significant effect on the temperature changes, the particle size at 180mm below revile region at which high amount of water absorption capacity can be achieved in terms of the quadratic model.

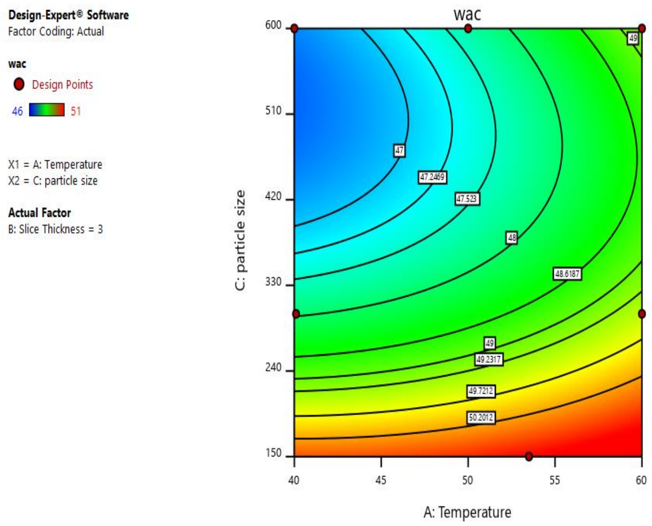


Fig. 7.: 2-dimensional plot of temperature and particle size on Water Absorption Capacity.

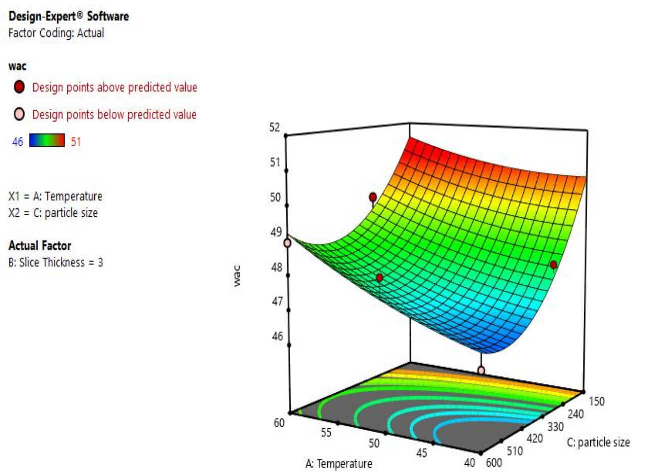


Fig. 8: 3-dimensional plot of temperature and slice thickness on Water Absorption Capacity

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Oil absorption capacity (OAC), Is a non-polar side protein chain binding of fat. The capacity of oil absorption is a crucial feature that helps to improve the mouth while retaining dietary products (Iwe *et al.,*2016; Danbaba et al 2014). Oil absorption capacity (OAC) reaction surface and contour outlines (Fig. 9 and 10), achievable with a maximum value of 20.07%. The factors interaction of Temperature and particle size indicated that the higher the factors the lower the oil absorption capacity. Oil absorption capacity (OAC) at lower temperature (> 50 º C) and particle size below 330mm region has relatively low percentage of OAC at 16 to 17 %. Figure 9, shows that slicing thickness and drying temperature had significant effect on oil absorption capacity (OAC), which was also confirmed by ANOVA (F-value 6.30 and p-value 0.03). The boundary level on the response at range of 19 to ≥20 % at temperature of 40 – 50 º C and at particle size above 330 to 600 µm. the slicing thickness of the sample was at 3mm. In diets that have a high protein content, the rate of oil absorption is particularly high. The capacity of oil and water to link proteins to foods depends on parameters such as the shape of protein, amino acid content and surface polarity or hydrophobicity (Suresh et al.,, 2015).

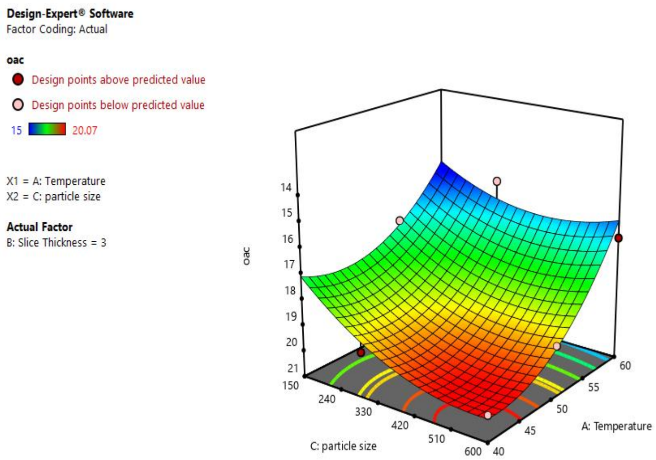

Fig. 9.: 3-dimensional plot of temperature and particle size on Oil Absorption Capacity.

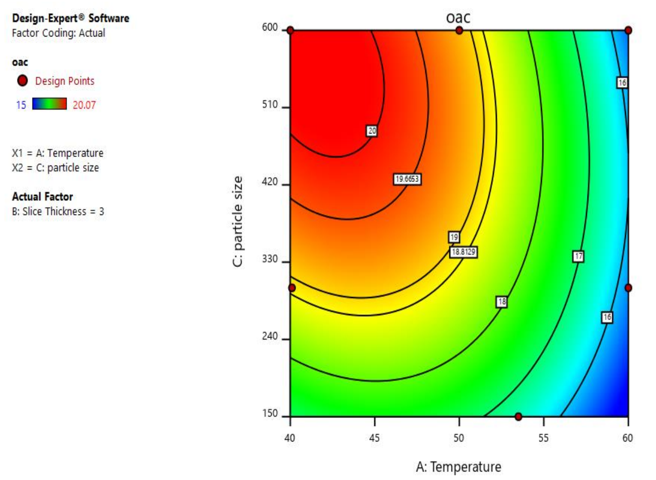

Fig. 10: 2-dimensional plot of temperature and particle size on Oil Absorption Capacity.

Gelatinization Temperature: the response surface and contour plot (Fig. 11 and 12) for the gelatinization Temperature with a maximum value of 98 ºC and minimum value of 82 ºC achieved at temperature and particle size of 40 - 60 ^{0} C and 150µm to 600µm respectively. The drying temperature had significant effect on gelatinization temperature while particle size has no significant effect, which was also confirmed by ANOVA of linear model (P-value = 0.027 and 0.69) respectively. The Maximum boundary level on the gel temperature response at range above 96 ºC at temperature of 40 – 45 º C and at all particle size. Gelatinizing temperature shall be the temperature at which starch gelatinisation is performed depending on the type and volume of water present in the plant; pH, salt and kinds of water, sugar, protein, fat, and the method of derivatization of starch employed in the recipe. Unchanged native starches start swelling at 55°C while certain types start swelling at 85°C (Awuchi, *et al.*,2019 ; Hans-Dieter *et al.*,2004).

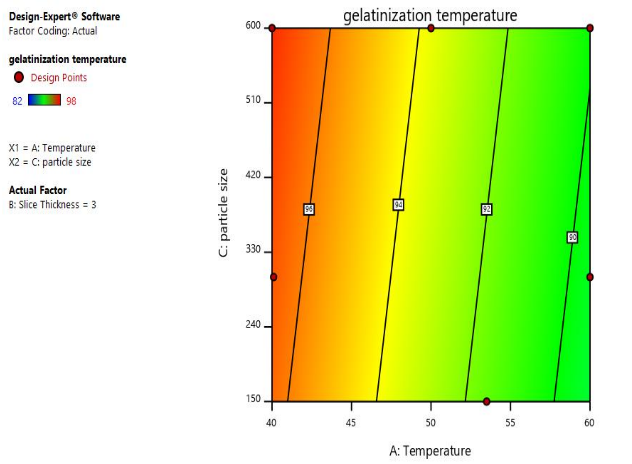

Fig. 11. : 2-dimensional plot of temperature and particle size on Gelatinization Temperature

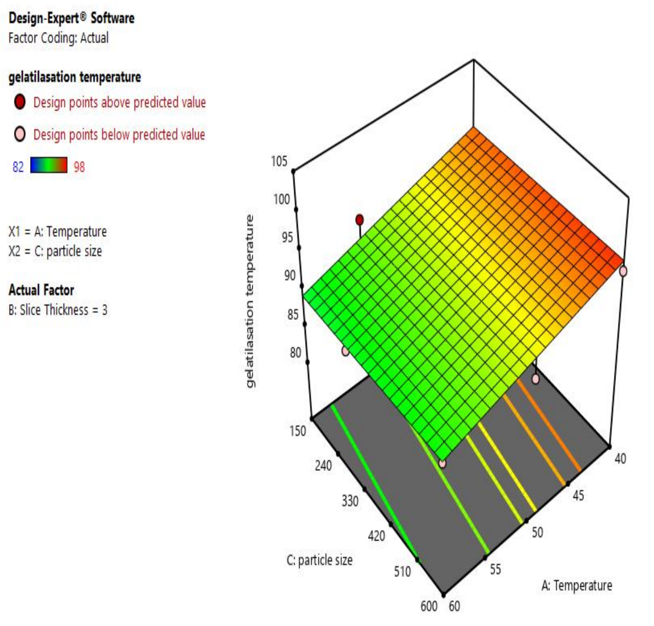

Fig. 12.: 3-dimensional plot of temperature and particle size on Gelatinization Temperature.

Least Gelatinization Concentration: The two-dimensional (contour) track and surface response graph explains the link between two components interaction (temperature and particle size) and the least-gelatinization of turmeric flour response concentration. It determines the lowest protein concentration at which a gel form is produced. The least gelatinization concentration falls as temperature increases and the particular size lowers, as seen in Figures 13 and 14. F flour of turmeric. The minimum and maximum gelatinization temperature of the total of experimental runs (20) are 6% and 10% respectively. The snug surface respond (Figure 14) to find a direction of potential enhancement for least gelatinization concentration process of the produced turmeric flours. The slicing thickness for the analysis at constant size of 3 mm, the maximum boundary at which the two factors interaction of temperature at all point 40 ºC to less than 50 ºC and at the particle size point above 420 µm with least gelatinization concentration 9.33303 % at maximum can be achieved. The influence of particle sizes varies without a great deal of significant effect, but the temperature changes at a P-value of 0.0043 in linear models with slice thickness of 3 mm. The less the LGC, the higher the protein ingredient's gelatin ability (Suresh *et al.*,2015) and its swelling capacity (Kaushal *et al.*,2012).

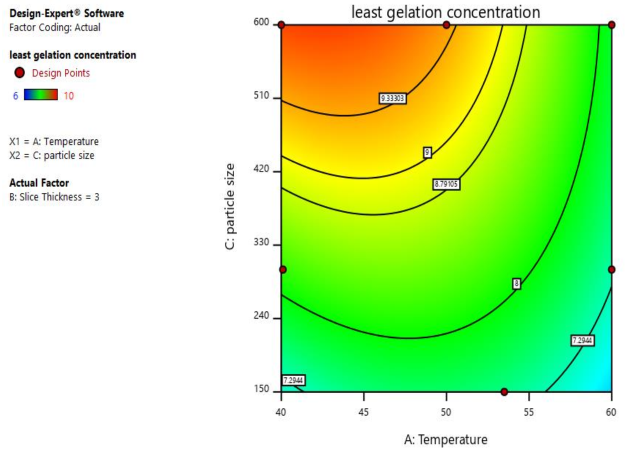

Fig.13: 2-dimensional plot of temperature and particle size of Least Gelatinization Concentration.

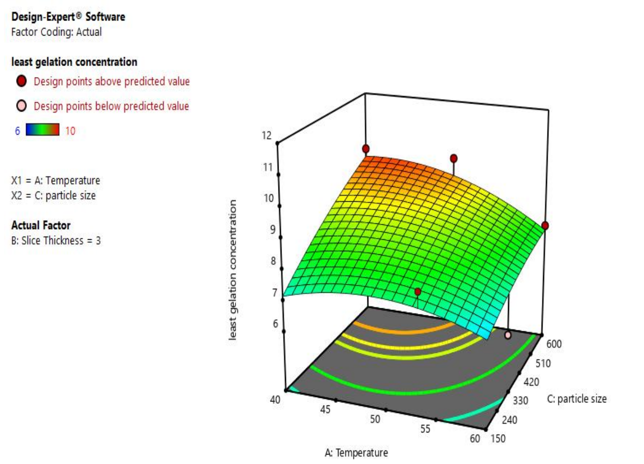

Fig. 14: 3-dimensional plot of temperature and particle size of Least Gelatinization Concentration.

Emulsion Capacity: is a mixture of two or more typically unmistakable liquids (unbendable or unmixable). Emulsions belong to the general class of matter-called colloids in two-phase food systems. The response surface and contour plot (Figs. 15 and 16) for the emulsion capacity with a maximum value of 38.84% and minimum value of 32.87% achieved at temperature and particle size of 40 - 60 ^{0}C and 3mm to 7mm respectively. The drying temperature had no significant effect on least gelation concentration while particle size had significant effect, which was also confirmed by ANOVA (P-value = 0.95 and 0.02) respectively. At a temperature range of 40 – 55 o C and a particle size of 240 m, the minimum boundary level on the product response is 32.87 to 36 percent. Protein's key functional features in flour including comminuted meat products, salad dressing, frozen desserts, and mayonnaise are emulsion capacity and stability, as well as fat binding during processing (Awuchi *et al.*,2019).

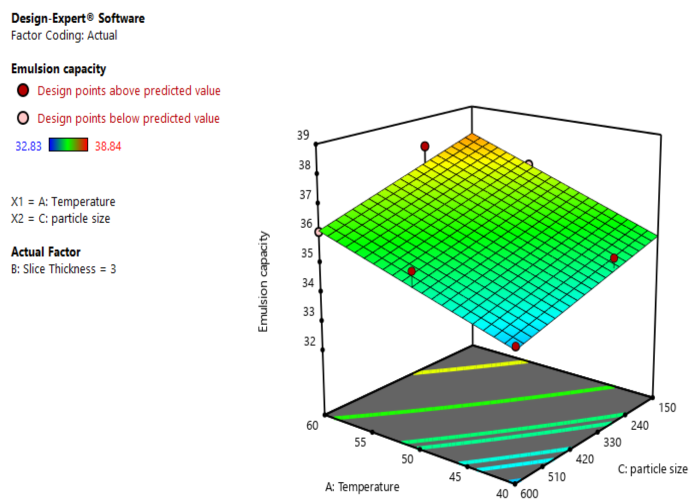

Fig. 15. : 3-dimensional plot of temperature and particle size of Emulsion Capacity.

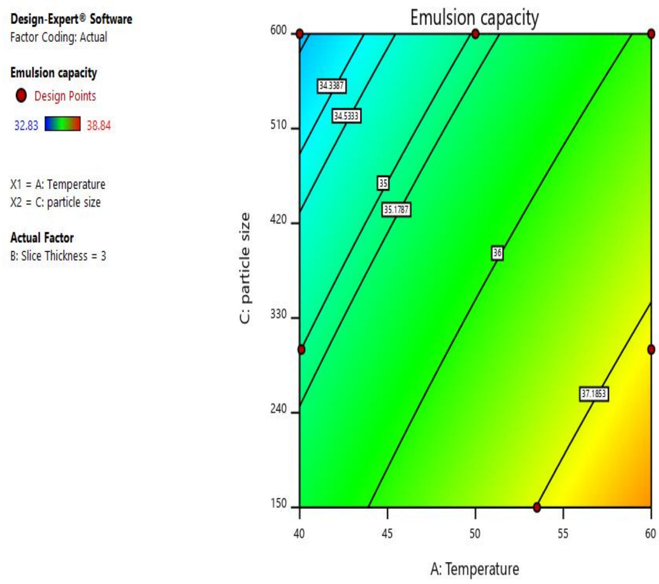

Fig. 16. : 2-dimensional plot of temperature and particle size of Emulsion Capacity.

Emulsion Stability: Emulsion stability refers to a food emulsion's capacity to withstand changes in its properties over time (McClements, 2004). Food (flour) emulsion instability includes sedimentation, coalescence, flocculation, Ostwald ripening, and creaming. The two factors and the reaction emulsion stability of turmeric flour (temperature and slice thickness). Contour plot and surface response plots help to understand the relationship between two interactional factors as can be seen in Figures 17 and 18, the emulsion stability decreases with a decrease in temperature and along the particle size of above 240 µm. The minimum and maximum emulsion capacity of the total twenty numbers of experimental runs are 31 and 36% respectively. Moreover, the fitted surface respond (Figure 18) to find a direction of potential enhancement for emulsion stability process of the produced turmeric flours. The particle size for the analysis at constant slicing thickness of 3mm, the maximum boundary at which the two factors interaction of temperature at all point 40 to 60 ºC and for all the particle size with emulsion stability less than 35.55% can be achieved. Particle size effect vary with much significant effect on the temperature changes, the particle size at 150 µm and ≤ 240 µm revile region at which high amount of emulsion capacity can be achieved in terms of the two-factor interaction model 2FI.

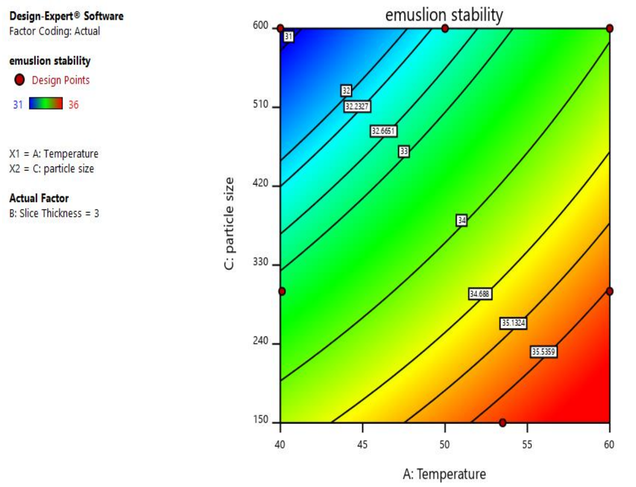

Fig. 17.: 2-dimensional plot of temperature and particle size of Emulsion Stability.

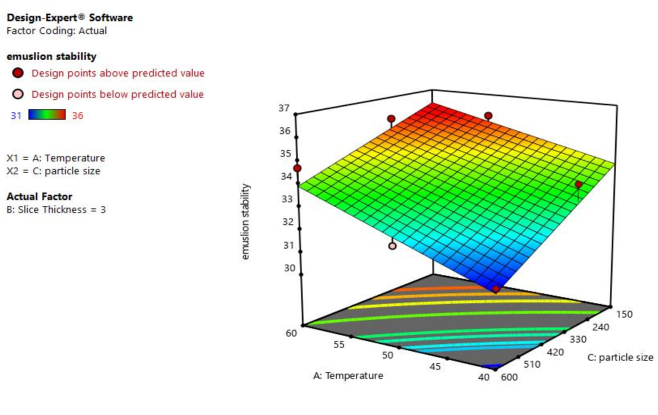

Fig. 18.: 3-dimensional plot of temperature and particle size of Emulsion Stability.

IV. CONCLUSION

In conclusion, turmeric flour has an excellent functional composition, it may be advantageous to the advancement and value enhancement of barking items. Two factors interaction shows the region where each property can be obtained at a high amount considering processing parameters (temperature slicing thickness) and particle size for foaming capacity, foaming stability, swelling index, and water absorption capacity of the flour shows optimum amount of water required to be added to a dough before it becomes excessively stick before it becomes excessively stick before it becomes excessively stick. Oil absorption capacity is said to increase the caloric value of food products, and the turmeric flour has a range of 15 -20.07 % percent. The gelatinization temperature of the turmeric flour was high compared to many other flours, at least 98 ºC, with the lowest gelatinization temperature ranges of 6 -10 shown in almost all boundary parts of the factor interaction, emulsion capacity, and emulsion stability increasing.

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