ijPPHT
e ISSN-2231-6426
Volume 7 | Issue 2 | December, 2016 | 220-227
Visit us: *www.researchjournal.co.in*
International Journal of Processing and Post Harvest Technology

RESEARCH PAPER

DOI: 10.15740/HAS/IJPPHT/7.2/220-227

Effect of olive oil and freeze dried beetroot powder on quality characteristics of chicken meat patties by response surface methodology study

RAYEES UL ISLAM AND MOHAMMAD ALI KHAN*
Department of Post Harvest Engineering and Technology, Aligarh Muslim University, ALIGARH (U.P.) INDIA
Email : billuraiz@gmail.com; makamu4@yahoo.co.in

*Author for Correspondence

Research chronicle : Received : 10.10.2016; **Revised :** 18.10.2016; **Accepted :** 19.11.2016

SUMMARY :
A two factor Central Composite Design (CCD) was applied to study the major effects and interactions of processing variables such as olive oil (5–15%) and beetroot powder (1-5%) on cooking properties of chicken patties. The addition of olive oil increased reduction in diameter, shrinkage and emulsion stability values however, reduction in thickness, fat and moisture retention, cooking yield values decreased as the amount of olive oil increased. On the other hand, the incorporation of beetroot powder decreased reduction in thickness and diameter, shrinkage and emulsion stability. Cooking yield and fat and moisture retention values were found to increase by the addition of beetroot powder.

KEY **W**ORDS : Beetroot powder, Olive oil, Patty, Response surface methodology, Cooking properties

How to cite this paper : Islam, Rayees Ul and Khan, Mohammad Ali (2016). Effect of olive oil and freeze dried beetroot powder on quality characteristics of chicken meat patties by response surface methodology study. *Internat. J. Proc. & Post Harvest Technol.,* **7** (2) : 220-227. **DOI: 10.15740/HAS/IJPPHT/7.2/220-227.**

Beta vulgaris L., generally well-known as the red beet or beetroot, is a root vegetable grown all over the world. It is not consumed frequently; however beets can be eaten raw or roasted, frequently served in soups or on salads. They contain betalains, which have been used as natural colorants in food products such as processed meat, ice cream, baked goods, candies and yogurt (Delgado-Wargas *et al.*, 2000 and Vereltzis *et al.*, 1984). Beetroot has also been used as a colorant in some ground meat products having low moisture content such as salami sausages that do not contains SO_2 (Jackman and Smith, 1996). Betalains are believed to contain great antioxidants, slow down cancer cell propagation and increasing resistance of low-density lipoproteins that are formed as a result of oxidation (Kapadia *et al.*, 1996; Wu *et al*., 2006; Tesoriere *et al*., 2004 and Gentile *et al*., 2004).

Great work has been done in recent years to make the processed meat industry better in order to improve the nutritional quality of meat and recoup consumer's expectations. The partial or full replacement of animal fat with vegetable oils in processed meat products is a recent trend. This process has been found to be a competent and successful approach to improve the nutritional value of meat products by declining saturated fatty acid levels and adding up natural antioxidants. Olive oil which is known to be rich in monounsaturated fatty acids-primarily oleic acid, have repressive effects on tumor development (Escrich *et al*., 2007) and it has been widely used as an animal fat replacer in meat products exhibited good results in terms of nutritional value and oxidative stability. Olive oil has been studied as a partial fat replacer in various meat products such as reduced-fat frankfurters (Choi *et al*., 2010 and López-López *et al*., 2009), liver pâté (Martín *et al*., 2008) and fermented sausages (Muguerza *et al*., 2001).

The present work was dedicated to study the effects of freeze dried beetroot powder (1-5%) and olive oil (5-15%) on cooking properties of cooked chicken patties.

EXPERIMENTAL METHODS

Preparation of freeze dried beetroot powder :

Beetroot was obtained from a local market and freeze dried in a Virtis lyophiliser (model FM12XL). Freeze dried beetroot was ground with a mill (0.025–0.05 mm particle size) and stored in deep freezer at -30^{o}C until use.

Patty preparation :

Lean meat from chicken leg and chest was obtained from a local market (Dodhpur, Aligarh, U.P. India). All subcutaneous fat was separated from the muscles and the meat ground with a 3 mm plate grinder. The spice mixture was then added to ground meat and two ingredients were used in various proportions. The two independent variables were olive oil and freeze dried beetroot powder. Test ingredients (olive oil and freeze dried beetroot powder) were mixed at levels varying from 5 to 15 per cent and 1 to 5 per cent, respectively. Appropriate proportions of olive oil (5 %, 10 % and 15 %) and beetroot powder (1 %, 3 % and 5 %) were added into each batch as shown in Table A. The emulsion was kneaded for 15 min using small size commercial mixer (Model 5KSM150, Kitchen Aid, Michigan, USA). Patties were cooked in a preheated electric grill set at 170–190^{0} C until core temperature of patties reached 75-80^{0} C. Core temperature of patties was monitored by water proof digital thermometer. After cooking, patty samples were allowed to cool to 25^{0} C in room conditions and then wrapped with polyethylene bags and frozen at -18^{0} C until further analysis.

Moisture retention :

Moisture retention of chicken patties was determined by an equation given

$$\text{Moisture retention (\%)} = \frac{(\text{\% Yield x \% Moisture in cooked patty})}{100}$$

Fat retention :

Fat retention was calculated according to the following equation.

$$\text{Fat retention (\%)} = \frac{(\text{Cooked weight x \% Fat in cooked patty})}{(\text{Raw weight x \% Fat in raw patty})} \text{x 100}$$

Reduction in thickness and diameter :

The reduction in thickness and diameter of patties was determined with the help of a digital calliper (Mitutoyo, Japan). The following equations were employed to determine the reduction in thickness and diameter, respectively.

$$\text{Reduction in thickness (\%)} = \frac{\text{Uncooked patty thickness} - \text{Cooked patty thickness}}{\text{Uncooked patty thickness}} \text{x 100}$$

$$\text{Reduction in diameter (\%)} = \frac{\text{Uncooked patty diameter} - \text{Cooked patty diameter}}{\text{Uncooked patty diameter}} \text{x 100}$$

Shrinkage :

The given equation was used to determine dimensional shrinkage of the patties

$$\text{Shrinkage (\%)} = \frac{(\text{Raw thickness} - \text{Cooked thickness}) + (\text{Raw diameter} - \text{Cooked diameter})}{(\text{Raw thickness} + \text{Raw diameter})} \text{x 100}$$

Cooking yield :

Weight of sausage before and after cooking was recorded and yield was expressed in percentage

$$\text{Cooking yield (\%)} = \frac{\text{Cooked patty weight}}{\text{Uncooked patty weight}} \text{x 100}$$

Emulsion stability :

Emulsion stability was determined using the method of Baliga and Madaiah (1970). Twenty gram of meat emulsion was taken in low density polyethylene bags and were put in a thermostatically controlled water bath at

Table A : Central composite design used to evaluate the effects of independent variables on cooking properties of chicken patties

	Coded variables		Uncoded variables	
Std	X_1	X_2	Olive oil (g)	Beetroot powder (g)
1	-1	-1	5	1
2	1	-1	15	1
3	-1	1	5	5
4	1	1	15	5
5	-1	0	5	3
6	1	0	15	3
7	0	-1	10	1
8	0	1	10	5
9	0	0	10	3
10	0	0	10	3
11	0	0	10	3
12	0	0	10	3
13	0	0	10	3

X_1, coded level of olive oil (%); X_2 coded level of beetroot powder (%)

80±1°C for 20 min. The bags were removed from water bath, cut open and the cooked out fluid was drained out. The cooked emulsion mass was weighed and expressed as percentage.

Experimental design and data analysis :

Central Composite Design (CCD) was used to study the effects of two independent variables namely, olive oil (5–15%) and beetroot powder (1-5%) (Table A). Moisture retention, fat retention, reduction in thickness, reduction in diameter, shrinkage, cooking yield and emulsion stability were selected as the dependent variables for the combination of the two independent variables. The experimental designs involved 13 experiments including 5 replications of the central point. Experiments were carried out in triplicates. The data obtained from the CCD design was fitted with a second order polynomial equation. The equation is as follows:

$$Y = \beta_0 + \sum_{i=1}^{2}\beta_i X_i + \sum_{i=2}^{2}\beta_{ii} X_i^2 + \sum_{i}^{2}\sum_{j=i+1}^{2}\beta_{ij} X_i X_j$$

where Y is the predicted response; β_0 is a constant; β_i is the linear co-efficient; β_{ii} is the quadratic co-efficient, β_{ij} is the interaction co-efficient; and X_i and X_j are independent variables. The adequacy of the model was determined by evaluating the lack of fit, co-efficient of regression (R^2) and the Fisher test value (F-value) obtained from the analysis of variance (ANOVA).

EXPERIMENTAL FINDINGS AND ANALYSIS

The results obtained from the present investigation as well as relevant discussion have been summarized under following heads :

Moisture retention :

The effect of fat and beetroot powder on moisture retention of patties is shown in Fig. 1. Table 1 illustrates that the linear effects of olive oil and beetroot powder were significant ($P < 0.001$). Moisture retention of patties decreased as the amount of fat increased ($P < 0.001$). These results were consistent with that of Serdaroglu

Table 1 : Analysis of variance for physico-chemical characteristics of chicken patties developed with olive oil and beetroot powder

	Model	Mean ±SD	Sum of squares	DF	Mean square	F value	Prob > F	R^2	Adj. R^2
Moisture retention	Linear	53.55±0.22	2.23	2	1.12	23.92	0.0002	0.83	0.79
Fat retention	Linear	79.37±2.26	195.75	2	97.88	19.09	0.0004	0.79	0.75
Thickness reduction	Linear	9.39±0.78	57.89	2	28.94	47.54	0.0001	0.90	0.89
Diameter reduction	Linear	8.37±0.46	59.82	2	29.91	139.61	0.0001	0.97	0.96
Shrinkage	Linear	8.51±0.46	33.65	2	16.83	81.08	0.0001	0.94	0.93
Cooking yield	Linear	90.11±0.42	15.93	2	7.97	44.53	0.0001	0.90	0.88
Emulsion stability	Quadratic	92.74±0.37	9.22	5	1.84	13.74	0.0017	0.91	0.84

Significant at $p < 0.001$

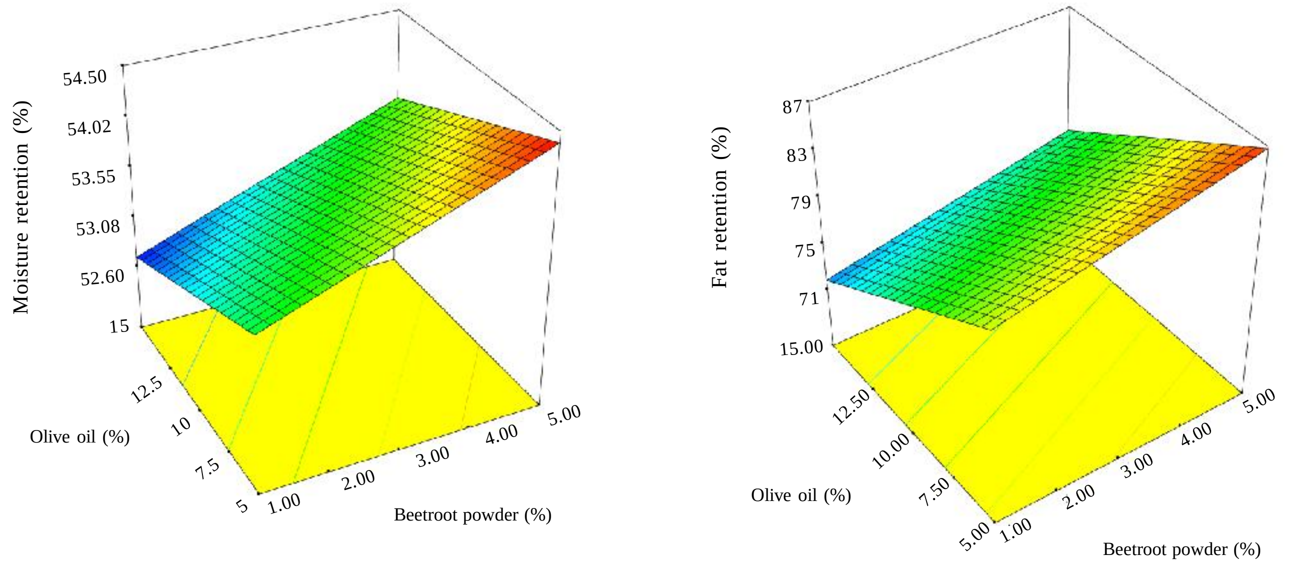

Fig. 1 : Response surface graph of moisture and fat retention of the chicken patties containing olive oil and beetroot powder

and Degirmencioglu (2004) who found that increasing fat levels in meatball formulations resulted in lower moisture retention. On the other hand beetroot powder increased moisture retention of patties ($P < 0.001$). This might be due to the water holding capacity of beetroot powder, thus increasing the moisture retention of patties. Maximum moisture retention of patties was found to be 54.40 per cent when 5 per cent beetroot powder and 5 per cent olive oil were used. Minimum moisture retention of patties was found to be 52.66 per cent when 1 per cent beetroot powder and 15 per cent olive oil were used. It can be concluded from these results that minimum fat and maximum beetroot powder is recommended to get higher moisture retention in chicken patties. The predicted model equation (Eq. 1) for moisture retention of patties is given below, where A: olive oil, B: beetroot powder.

$$\text{Moisture retention} = +\ 53.55 - 0.37 *A + 0.48*B \qquad (1)$$

Fat retention :

The results showed that olive oil and beetroot powder had significant effect on fat retention of patties (Table 1). Increasing fat levels found to decrease fat retention values ($P < 0.001$) (Fig. 1). These results were found to be consistent with results of Serdaroglu and Degirmencioglu (2004) who determined that fat retention decreased with increasing fat levels. In addition, Mansour and Khalil (1999) observed that more fat retained in low-fat patties as compared to high-fat patties during cooking. On the other hand, increasing beetroot powder had an increasing effect ($P < 0.05$) on fat retention values of patties due to its oil holding capacity. Higher fat retention was found when 5 per cent olive oil and 5 per cent beetroot powder were used in patty formulation. However, lower fat retention values in patties were found when 15 per cent olive oil and 1 per cent beetroot powder were used. The predicted model equation (Eq. 2) for fat retention of patties is given below, where A: olive oil, B: beetroot powder.

$$\text{FAt retention} = +\ 79.37 - 5.25*A + 2.25*B \qquad (2)$$

Reduction in thickness and diameter :

Olive oil and beetroot powder had a significant effect on thickness reduction in cooked patties as shown in Table 1. Both Olive oil and beetroot powder significantly decreased ($P < 0.001$ and $P < 0.05$, respectively) reduction in thickness of patties as shown in Fig. 2. On the other hand olive oil had significant effect on reduction in diameter ($P < 0.001$). It increased the reduction in patty diameter (Fig. 2). These results were in line with the findings of Serdaroglu and Degirmencioglu (2004) who confirmed that meatballs developed with 20 per cent fat had the higher decrease in diameter. Beetroot powder decreased the reduction in diameter ($P < 0.01$) (Fig. 2). This might be due to the fact that beetroot powder had ability to hold fat and water that contributed to a decrease in the diameter reduction of the patty samples. It was determined that the reduction in patty thickness varied between 5.17 per cent and 13.78 per cent while

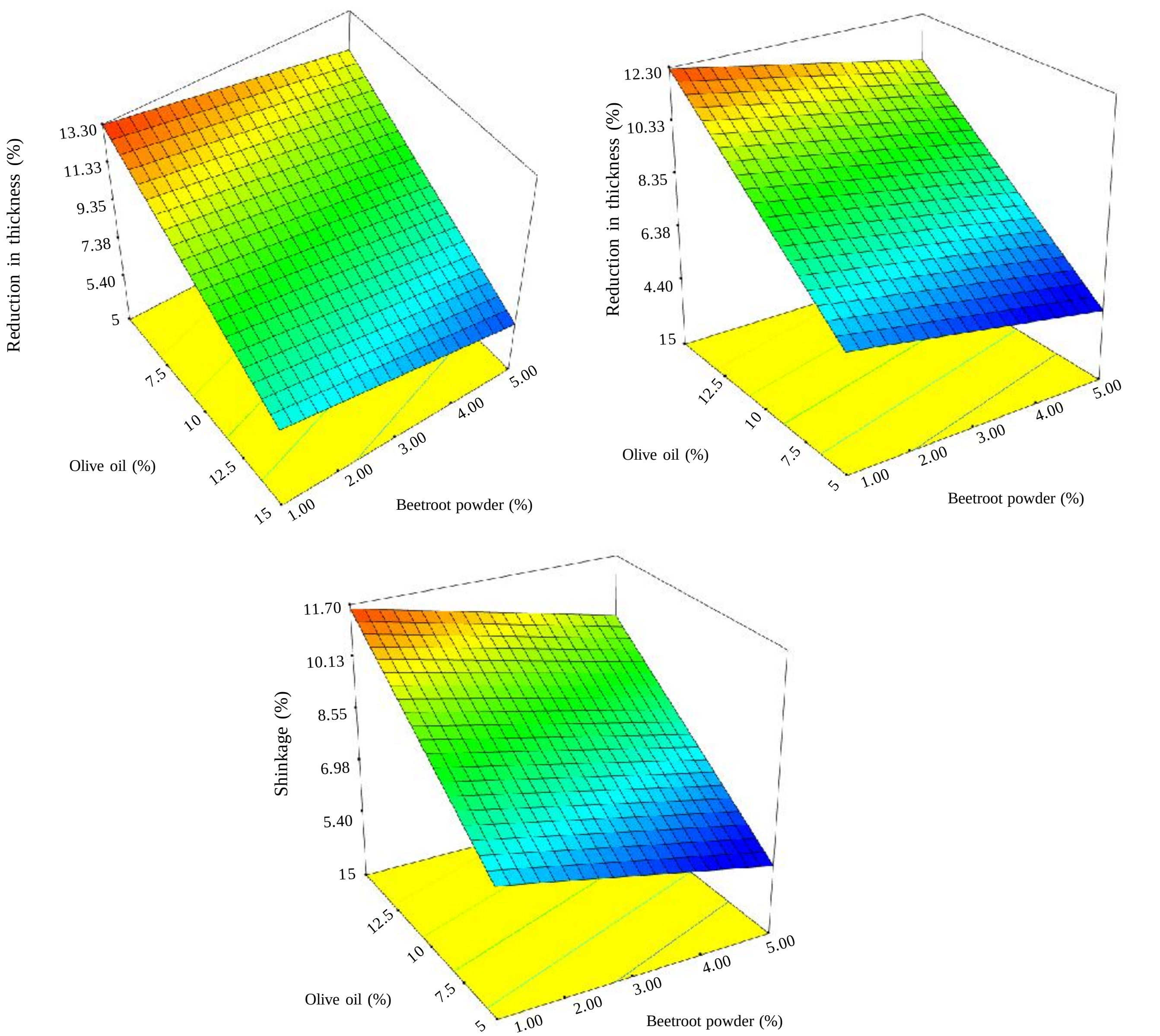

Fig. 2 : Response surface graph of reduction in thickness, reduction in diameter and shrinkage of the chicken patties containing olive oil and beetroot powder

that of diameter differed from 4.97 per cent to 12.54 per cent within the investigated ranges of independent parameters. Minimum and maximum reduction in patty thickness was found when 5 per cent olive oil and 15 per cent beetroot powder and 1 per cent olive oil and 5 per cent beetroot powder were used in patty formulation, respectively. On the other hand lowest reduction in patty diameter was found when 5 per cent olive oil and 5 per cent beetroot powder were utilized and maximum reduction in patty diameter was found when 15 per cent olive oil and 5 per cent beetroot powder were utilized in patty formulation. The predicted model equation (Eq. 3 and 4) for thickness reduction and diameter reduction of patties is given below, where A: olive oil, B: beetroot powder.

Thickness (%) = +9.39-2.96*A -0.94*B (3)

Diameter (%) = +8.37+3.040*A-0.86*B (4)

Shrinkage :

Both fat and beetroot powder had a significant (Table

1) ($P < 0.0001$ and $P < 0.005$, respectively) effect on the shrinkage properties of patties. The effect of fat and beetroot powder incorporation on shrinkage of patties is shown in a three dimensional graph (Fig. 2). The results of this study showed that the shrinkage rate varied between 5.84 per cent and 11.82 per cent in the patty samples. Least shrinkage (5.84%) was reported to occur at fat = 5 per cent and beetroot powder = 5 per cent. Maximum shrinkage (11.82%) was determined at fat = 15 per cent and beetroot powder = 1 per cent. Velioglu *et al*. (2010) reported that the fat level affected cooked hamburger patty shrinkage and reducing the fat level from 30 per cent to 10 per cent significantly reduced shrinkage. Similar trend was observed in this study. Increasing the fat per cent from 5 per cent to 15 per cent increased the shrinkage values in patty samples. Also, It has been found from the results of Younis and Ahmad (2015) that apple pomace powder incorporated sausages cause significantly less shrinkage compared to control sausage.

A model equation was detailed to predict the shrinkage rate on the basis of oil and beetroot powder content. Fitting of the information to different models and their ensuing ANOVA demonstrated that shrinkage could be anticipated by utilizing a straight model as the function of independent parameters (Eq. 5), where A: olive oil, B: beetroot powder.

$$\text{Shrinkage (\%)} = +8.51 + 2.20*A - 0.88*B \qquad (5)$$

Cooking yield :

Cooking yield is the most critical factor for the meat manufacturing in forecasting the behaviour of products in cooking due to the inclusion of non-meat ingredients or other factors (Pietrasik and Li-Chan, 2002). Fig. 3 describes the impacts of beetroot powder and olive oil on cooking yield of patty samples as three-dimensional graphs. Beetroot powder was the variable, which linearly affected cooking yield ($P < 0.001$). Beetroot powder caused an increase in cooking yield of patty samples. This might be due the capacity of beetroot powder to retain the moisture and fat. According to the findings of Yadav *et al.* (2016) cooking yield increased significantly by the addition of tomato pomace powder. On the other hand, cooking yield of patties was found to decrease significantly ($P < 0.001$) by increasing the oil content. Similar results were found by Jung and Joo (2013) in pork patties which contained soybean oil. It was found that the cooking yield of patties ranged from 87.60 per cent and 92.60 per cent. Minimum cooking yield was observed at fat = 10 per cent and beetroot powder = 1 per cent. Maximum cooking yield of patties was determined at fat = 5 per cent and beetroot powder = 5 per cent. The predicted model equation (Eq. 6) for cooking yield of patties is given below, where A: olive oil, B: beetroot powder.

$$\text{Cooking yield} = +90.11 - 0.95*A + 1.32*B \qquad (6)$$

Emulsion stability :

Fig. 3 demonstrates the impact of oil and beetroot powder on the emulsion stability on the different meat emulsion groups examined. Both olive oil and beetroot

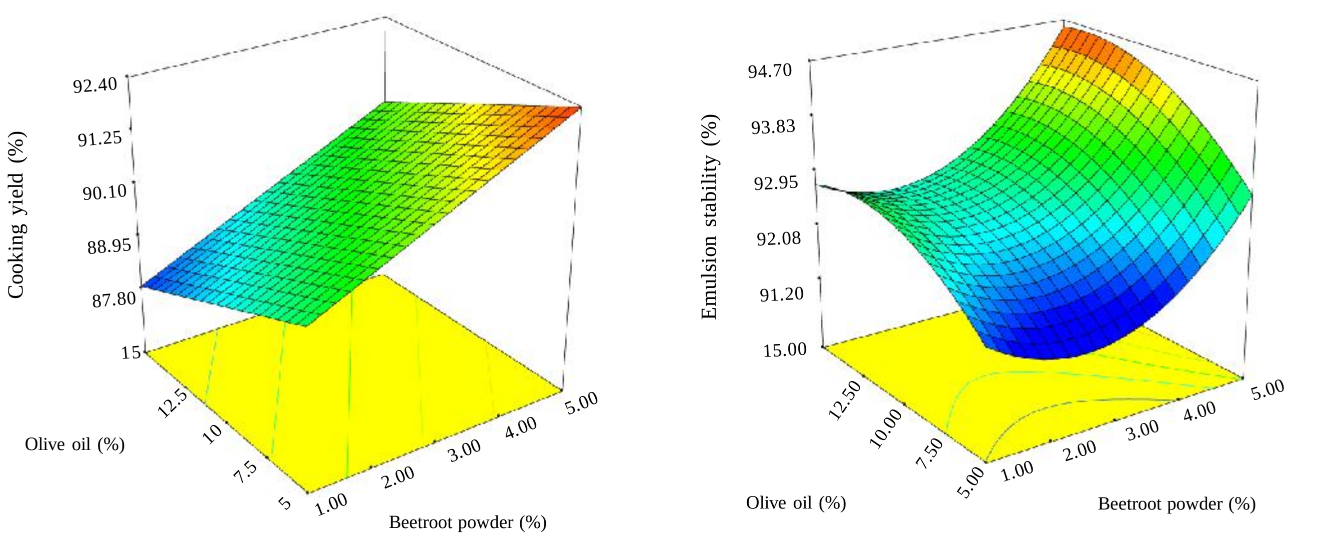

Fig. 3 : Response surface graph of cooking yield and emulsion stability of the chicken patties containing olive oil and beetroot powder

powder significantly ($P<0.01$) increased emulsion stability of meat samples as shown in Table 1. According to the findings of Pappa *et al.* (2000) a significant impact was found on jelly and fat separation of low-fat frankfurters prepared with different proportion of olive oil and pectin. Similarly, emulsion stability of batters made with grape seed oil and rice bran fibre was found to increase significantly (Choi *et al.*, 2010). However, Luruen a-Martiynez *et al.* (2004) reported that there were no significant differences in jelly and fat separation of frankfurters developed with olive oil than those prepared with same animal fat content. Tan *et al.* (2006) reported that there was no fluid loss in stable meat batters after 1 h at 75^0 C carrying different fats indicating a strong emulsion complex formation. The predicted model equation for the emulsion stability of patties prepared with olive oil and beetroot powder is given below (Eq. 7), where A: olive oil, B: beetroot powder.

$$\text{Emulsion stability} = +92.49 \;+0.65*A \;+0.76*B \;+0.16*A*B \;-0.53*A^2 \;+1.06*B^2 \qquad (7)$$

Conclusion :

During this study it was found that beetroot powder and olive oil showed positive results on cooking parameters of chicken patties. Beetroot powder improved emulsion stability, cooking yield, fat and moisture retention which are believed to be crucial parameters in the production of meat products. The developed models can be employed to produce a best formula for patty production. It can be concluded from this study that animal fat can be partially or completely replaced by olive oil not only to produce a low fat meat product but also to obtain a more healthy food due to its high content of monounsaturated fatty acids and vitamin E. Thus, the findings of this study could be beneficial for meat processing industries that tend to enhance the product yield for patties using the optimum levels of olive oil and beetroot powder.

LITERATURE CITED

Baliga, B.R. and Madaiah, N. (1970). Quality of sausage emulsion prepared from mutton. *J. Food Sci.*, **35** : 383–385.

Choi, Y.S., Choi, J.H., Han, D.J., Kim, H.Y., Lee, M.A., Jeong, J.Y., Chung, H.J. and Kim, C.J. (2010). Effects of replacing pork back fat with vegetable oils and rice bran fibre on the quality of reduced-fat frankfurters. *Meat Sci.*, **84** (3): 557-563.

Choi, Y.S., Choi, J.H., Han, D.J., Kim, H.Y., Lee, M.A., Kim, H.W. and Kim, C.J. (2010). Optimization of replacing pork back fat with grape seed oil and rice bran fibre for reduced-fat meat emulsion systems. *Meat Sci.*, **84**(1) : 212–218.

Delgado-Wargas, F., Jimenez, A.R. and Lopez, O.P. (2000). Natural pigments. Carotenoids, anthocyanins and betalains-Characteristics, biosynthesis, processing and stability. *Crit. Rev. Food Sci. Nutr.*, **40** : 173-289.

Escrich, E., Moral, R., Grau, L., Costa, I. and Solanas, M. (2007). Molecular mechanisms of the effects of olive oil and other dietary lipids on cancer. *Mol. Nutr. Food Res.*, **51** (10): 1279-1292.

Gentile, C., Tesoriere, L., Allegra, M., Livrea, M.A. and D'Alessio, P. (2004). Antioxidant betalains from cactus pear (Opuntia ficus-indica) inhibit endothelial ICAM-1 expression. *Signal Trans. & Comm. Cancer Cells*, **1028** : 481-486.

Jackman, R.L. and Smith, J.L. (1996). Anthocyanins and betalains. In G.F. Hendry & J.D. Houghton (Eds.) Natural food colorants (244-309). London, Great Britain: Blackie Academic & Professional.

Jung, E. and Joo, N. (2013). Roselle (*Hibiscus sabdariffa* L.) and soybean oil effects on quality characteristics of pork patties studied by response surface methodology. *Meat Sci.*, **94**(3) : 391–401.

Kapadia, G.J., Tokuda, H., Konoshima, T. and Nishino, H. (1996). Chemoprevention of lung and skin cancer by *Beta vulgaris* (beet) root extract. *Cancer Lett.*, **100** (1-2) : 211-214.

López-López, I., Cofrades, S. and Jiménez-Colmenero, F. (2009). Low-fat frankfurters enriched with n-3 PUFA and edible seaweed: Effects of olive oil and chilled storage on physico-chemical, sensory and microbial characteristics. *Meat Sci.*, **83**(1) : 148–154.

Luruen a-Martynez, M.A., Vivar-Quintana, A.M. and Revilla, I. (2004). Effect of locust bean/xanthan gum addition and replacement of pork fat with olive oil on the quality characteristics of low-fat frankfurters. *Meat Sci.*, **68** : 383–389.

Mansour, E.H. and Khalil, A. H. (1999). Characteristics of low-fat beefburgers as influenced by various types of wheat fibres. *J. Sci. Food Agric.*, **79**(4) : 493–498.

Martín, D., Ruiz, J., Kivikari, R. and Puolanne, E. (2008). Partial replacement of pork fat by conjugated linoleic acid and/or olive oil in liver pâtés: Effect on physico-chemical characteristics and oxidative stability. *Meat Sci.*, **80**(2) : 496–504.

Muguerza, E., Gimeno, O., Ansorena, D., Bloukas, J.G. and Astiasaran, I. (2001). Effect of replacing pork backfat with pre-emulsified olive oil on lipid fraction and sensory quality of Chorizo de Pamplona – A traditional Spanish fermented sausage. *Meat Sci.*, **59** : 251–258.

Pappa, I.C., Bloukas, J.G. and Arvanitoyannis, I.S. (2000). Optimization of salt, olive oil and pectin level for low-fat frankfurters produced by replacing pork backfat with olive oil. *Meat Sci.*, **56** : 81–88.

Pietrasik, Z. and Li-Chan, E.C.Y. (2002). Binding and textural properties of beef gels as affected by protein, carrageenan and microbial transglutaminase addition. *Food Res. Internat.*, **35** : 91-98.

Serdaroglu, M. and Degirmencioglu, O. (2004). Effect of fat level (5%, 10%, 0%) and corn flour (0%, 2%, 4%) on some properties of Turkish type meatballs (koefte). *Meat Sci.*, **68** : 291–296.

Tan, S.S., Aminah, A., Zhang, X.G. and Abdul, S.B. (2006). Optimizing palm oil and palm sterarin utilization for sensory and textural properties of chicken frankfurters. *Meat Sci.*, **72**(3) : 387–397.

Tesoriere, L., Allegra, M., Butera, D. and Livrea, M.A. (2004). Absorption, excretion, and distribution of dietary antioxidant betalains in LDLs: Potential health effects of betalains in humans. *Am. J. Clin. Nutr.*, **80** (4) : 941 – 945.

Velioglu, H.M., Velioglu, S.D., Boyaci, I.H., Yilmaz, I. and Kurultay, A. (2010). Investigating the effects of ingredient levels on physical quality properties of cooked hamburger patties using response surface methodology and image processing technology. *Meat Sci.*, **84**(3) : 477–483.

Vereltzis, K., Buck, E.M. and Labbe, R.G. (1984). Effectiveness of a betalains, potassium sorbate system versus sodium nitrite for color development and control of total aerobes. *Closiridium perfingens* and *Clostridium sporogenes* in chicken frankfurters. *J. Food Prot.*, **47**: 532-536.

Wu, L., Hsu, H.W., Chen, Y.C., Chiu, C.C., Lin, Y.I. and Ho, J.A. (2006). Antioxidant and antiproliferative activities of red pitaya. *Food Chem.*, **95**(2) : 319–327.

Yadav, S., Malik, A., Pathera, A., Islam, R.U. and Sharma, D. (2016). Development of dietary fibre enriched chicken sausages by incorporating corn bran, dried apple pomace and dried tomato pomace. *Nutr. Food Sci.*, **46**(1) : 16–29.

Younis, K. and Ahmad, S. (2015). Waste utilization of apple pomace as a source of functional ingredient in buffalo meat sausage. *Cogent Food Agric.*, **1**(1) : 1-10.

7th Year
★★★★★ of Excellence ★★★★★