J. Meat Sci. 2019, 14 (1&2): 30-35 Research paper

Quality of Chicken Patties with Different Levels of Tapioca Flour Prepared by Using Food Processer

B. Ramachendra Reddy, P.K. Mandal*, S. Kasthuri and U.K. Pal

Department of Livestock Products Technology, Rajiv Gandhi Institute of Veterinary Education and Research, Kurumbapet, Pondicherry – 605009

ABSTRACT

A study was conducted to prepare spent hen meat patties by incorporation of tapioca flour and to compare the quality and economics of such patties processed by using food processor and bowl chopper. Chicken meat patties with 3% maida (control) and different levels of tapioca flour (3, 5 and 7%) prepared by using food processor were subjected to physico-chemical, chemical composition and sensory analysis. Results revealed that patties containing 5 and 7% tapioca flour had significantly ($P<0.05$) higher emulsion pH, emulsion stability (%) and cooking yield (%) than control. The sensory scores were desirable for appearance (7.30 to 7.57), flavour (7.03 to 7.33), texture (7.03 to 7.27), juiciness (6.90 to 7.20) and overall acceptability (7.10 to 7.43) on 8-point hedonic scale. No significant ($P>0.05$) differences were observed in sensory quality of patties containing different levels of tapioca flour, but 5% tapioca flour incorporated patties had non-significantly higher overall acceptability. The patties prepared with incorporation of 3 and 5% tapioca flour had significantly ($P<0.05$) higher protein and fat contents than patties containing 7% tapioca flour. Hence, formulation with 5% tapioca flour was selected over 3% tapioca flour to replace more meat portion. The patties processed by using bowl chopper had significantly ($P<0.05$) higher emulsion stability (95.26%) and texture score (7.63) compared to patties processed by using food processor, but all other parameters remained unaffected. Quality of patties prepared by using food processor and bowl chopper were comparable. The cost of production of patties prepared by incorporating different levels of tapioca flour by replacing the meat decreased proportionately. Since the food processor is very cheap (Rs 5000), it is economical to prepare patties by incorporating 5% tapioca flour using food processor without affecting sensory and physico-chemical qualities for small scale production.

Keywords: *Spent hen meat patties, Tapioca flour, Food processor, Bowl chopper, Physico-chemical quality, Sensory quality*

Received: 20/4/2020 Accepted: 12/5/2020

INTRODUCTION

Animal origin foods are particularly rich in highly bio-available protein, iron, zinc, vitamin A, vitamins B2 and B12 which are often deficient or absent in vegetarian diets (Bruyn et al., 2015). Poultry products are universally popular because they are not subject to cultural or religious constraints and the meat itself is perceived as wholesome, healthy and nutritious, being relatively low in fat and with more desirable unsaturated fatty acid content (Naveena *et al.,* 2014). Emulsion based comminuted meat products such as patties, nuggets etc. are highly popular among the consumers because of their easy availability and convenience. Meat extenders, binders and fillers are non-meat substances used with the objective of making comminuted meat products cost effective with improvement in desirable functional properties, such as emulsion stability, water binding capacity, product yield and enhancement of flavor and texture (Nagamallika *et al.,* 2006).

Tapioca (Manihot esculenta) is a dicotyledonous perennial woody shrub with an edible starchy root, belonging to the family Euphorbiaceae. It belongs to roots and tuber crops that stores edible material in tuber (Howeler, 2003) which belong to class of foods that basically provide energy in the human diet in the form of carbohydrates. Tapioca flour is extracted from cassava (tapioca) root after gelatinization. Tapioca starch possesses special properties such as high adhesiveness, a clear and transparent appearance, smooth texture and no off-flavors (Russ *et al.,* 2016). It is a good energy source due to its high starch content and is currently used as a staple food in many regions (Breuninger *et al.,* 2009) and can be utilized to develop varieties of novel products for consumers with increase in overall acceptability (Raheem and Chikwuma,2001).

Normally meat batter/emulsion is prepared in bowl chopper for medium to large scale production of emulsion type comminuted meat products which is not suitable for small scale (household) production for its prohibitory cost. Since the chicken products are far from the reach of common consumers and a promising market of home-made foods is developing elsewhere, trials are to be conducted to develop value added products utilizing cheap and easily available non-meat ingredients using low cost equipment for local market. Hence, an attempt was made to prepare patties using spent hen meat and tapioca flour by using food processor to reduce the product cost without compromising the quality of the product.

MATERIALS AND METHODS

Meat source: Spent hens were procured from the Institution farm and were slaughtered and dressed in the semi-automatic dressing plant in the department following standard procedures. Dressed carcasses were chilled at 4±1°C overnight and manual deboning was carried out following strict hygienic measures. Deboned meat was stored in 1 kg LDPE packages at -18±1°C till further use.

Selection of suitable level of tapioca flour for patties preparation: Patties were prepared by using refined wheat flour i.e., maida (control) and three different levels of tapioca flour using food processor by adopting previously standardized recipe and procedure (Reddy et al. 2018). Maida at 3% level and tapioca flour were incorporated at 3, 5 and 7% levels by replacing meat

*Corresponding author E-mail address: mandalpkm@gmail.com

DOI : 10.5958/2581-6616.2019.00007.0

in control, T1, T2 and T3, respectively. The best level of tapioca flour was selected based on physico-chemical properties and sensory attributes of patties.

Comparison of patties prepared by using food processor and bowl chopper: Patties were prepared by using food processer as standardized earlier (Reddy et al. 2018) and bowl chopper with the selected level of tapioca flour to compare the quality. The quality of patties was analyzed based on physico-chemical properties, chemical composition and sensory attributes of patties.

Preparation of patties using bowl chopper: Partially thawed deboned frozen spent hen meat was minced using meat mincer (MADO junior model, Germany) using 8 mm diameter plates. Minced chicken was chopped for one minute in bowl chopper (MADO Garant, Germany), after addition of salt, sugar, phosphate and ice-water for protein extraction followed by addition of vegetable oil and further running for 30 seconds. Finally condiments, spices and binders were added and bowl chopper was run for another 30 seconds. The patties were cooked in electrical grilling oven at 1600C for 40 minutes by turning the side after 20 minutes of cooking.

Physico-chemical analyses and chemical composition: The cooking yield (%) of patties was calculated following Murphy et al. (1975). The pH of emulsion and patties was determined by following the procedure of AOAC (1995) using combined glass electrode of the pH meter. Emulsion stability (%) was determined based on the method reported by Townsend et al., (1975). Chemical composition including moisture, crude protein and fat contents of the patties were determined as per AOAC (1995).

Sensory Evaluation: A 10 member semi-trained panel recorded their preference on 8 point hedonic scale (8=extremely desirable, 1=extremely undesirable) (Keeton, 1983) for the sensory attributes of the patties viz. appearance, flavor, texture, juiciness and overall palatability. Plain water was provided to each panelist to rinse the mouth in between the samples.

Statistical Analysis: Each experiment was replicated thrice and each parameter was analyzed in duplicate. The data were analyzed using SPSS version 16.0 (SPSS, Chicago, U.S.A). One way analysis of variance (ANOVA) was used to analyze the effect of different levels of tapioca flour on patties for physico-chemical quality, chemical composition and sensory attributes. Comparative quality of patties prepared by using food processor and bowl chopper was analyzed with t-test. The level of significance was tested using the least significant difference (LSD) test (Snedecor and Cochran, 1994).

RESULTS AND DISCUSSION

Patties were prepared by incorporating different levels of tapioca flour by replacing meat using food processor. Comparative study of quality of patties prepared by using food processor to that of bowl chopper was conducted. Economics of patties prepared with different levels of tapioca flour using food processor and bowl chopper were compared.

Selection of suitable level of tapioca flour

Effect of incorporation of tapioca flour (TF) on physico-chemical properties of patties: Physico-chemical properties of tapioca flour (TF) incorporated chicken patties are presented in table 1. The cooking yield (%), pH of emulsion and patties and emulsion stability (%) of control and treatments ranged from (83.48±0.08 to 86.63±0.2), (6.09±0.00 to 6.11±0.00), (6.21±0.00 to 6.25±0.00) and (88.59±0.09 to 95.16±0.07), respectively. Patties incorporated with 5 and 7% TF had significantly ($p<0.05$) higher cooking yield and emulsion stability than control and 3% TF incorporated chicken patties. This might be due to more water binding by increased TF levels. The pH of emulsion and pH of patties were significantly ($P<0.05$) higher for patties incorporated with 5 and 7% TF than control and samples containing 3% TF with no significant ($P>0.05$) difference between products with 5% and7% TF.

Similar findings of increased cooking yield (%) were reported by Chatterjee *et al.* (2014); Mohammad *et al.* (2009) and Hughes *et al.* (1998) with the incorporation of TF on chicken breast meat patties (at 1%, 2% and 3% levels), low fat buffalo meat patties (at 2, 3 and 4% levels) and low fat frankfurter beef sausages (at 1% and 2% levels) respectively. Turkey meat patties prepared with 4% tapioca starch had higher cooking yield (%) and emulsion stability (%) than patties prepared with 2 and 3% tapioca starch (Chatli *et al.,* 2010). Ponsingh et al. (2011) observed that incorporation of 7 and 10% of TF in buffalo meat sausages increased the emulsion stability. Muthia et al. (2012) reported similar pH values in duck meat sausages prepared by incorporating 4% tapioca starch. Similar pH values were recorded in spent broiler breeder meat patties prepared by incorporating 10% black gram paste (Gawdaman *et al.,* 2009) and in spent hen meat patties containing 15% pressed rice flour (Kumar and Sharma, 2005).

Effect of incorporation of tapioca flour (TF) on chemical composition of patties: The moisture, protein and fat contents of control and treatments (Table 1) were (61.26±0.14 to 63.24±0.06%), (18.70±0.06 to 20.13±0.13%) and (8.73±0.06 to 9.31±0.07%), respectively. The moisture, protein and fat contents of patties were significantly ($P<0.05$) affected by different levels of TF incorporation. There was proportionate decrease in moisture, protein and fat contents of patties with increased levels of TF incorporation.

Patties prepared with 7% TF had significantly ($P<0.05$) lower moisture, protein and fat contents than those of patties containing 3 and 5 % TF. Decrease in moisture, protein and fat contents of patties with higher level of TF might be due increase in carbohydrate content as TF contains higher amount of carbohydrate than maida. Control had significantly ($P<0.05$) higher protein and fat content than tapioca flour treated patties which may be attributed to more meat proportion in control

Table 1: Effect of different levels of tapioca flour incorporation on the physico- chemical properties and chemical composition of patties (Mean ± SE)

Parameters	Control	Level of tapioca flour incorporation (0.5%)	(1.0%)	(1.5%)
Cooking yield (%)	83.48±0.08[a]	83.61±0.14[a]	85.42±0.10[b]	86.63±0.21[c]
pH of emulsion	6.09±0.00[a]	6.09±0.00[a]	6.11±0.00[b]	6.11±0.00[b]
pH of patties	6.21±0.00[a]	6.23±0.00[b]	6.25±0.00[c]	6.25±0.00[c]
Emulsion stability (%)	88.59±0.09[a]	91.24±0.15[b]	95.01±0.15[c]	95.16±0.07[c]
Moisture (%)	63.21±0.20[c]	63.24±0.06[c]	62.32±0.11[b]	61.26±0.14[a]
Protein (%)	20.13±0.13[c]	19.88±0.23[bc]	19.47±0.08[b]	18.70±0.06[a]
Fat (%)	9.31±0.07[c]	9.18±0.08[bc]	8.97±0.07[b]	8.73±0.06[a]

Means with different superscripts in the same row differ significantly (P<0.05)

and comparatively higher protein and fat in maida. Similar findings were observed by Muthia et al. (2012) in duck meat sausages prepared with 4% TF with significantly (P<0.05) lower moisture, protein and fat contents than sausages prepared with combination of 3% tapioca flour and 1% egg white powder. Reduction in moisture content with increased levels of flour was observed in beef patties containing oat flour in the formulation (Serdaroglu, 2006). Spent hen meat patties incorporated with 15% pressed rice flour had lower moisture, protein and fat contents than patties containing the same but at 5% and 10% levels (Kumar and Sharma, 2005).

Effect of incorporation of tapioca flour on sensory quality of patties: The sensory scores of patties (table 2) incorporated with different levels of TF were desirable which ranged between 7.30 to 7.57; 7.03 to 7.33; 7.03 to 7.27; 6.90 to 7.20 and 7.10 to 7.43 on 8-point hedonic scale for appearance, flavor, texture, juiciness and overall acceptability, respectively. There was no significant (P>0.05) difference between control and the treatments. Numerically overall acceptability was higher for 5% TF incorporated chicken patties. The increase in overall acceptability scores might be due to the higher scores of appearance and flavor. These results were in agreement with Chatterjee et al. (2014) who studied chicken breast patties containing 2% tapioca flour, garbanzo flour, potato flour and egg white. Further, Chatli et al. 2010), Muthia et al. (2012), Ponsingh et al. (2011) and Ruban et al. (2008) reported similar sensory scores for turkey meat patties prepared with 2, 3 and 4% tapioca starch, duck sausages with 4% sago egg white powder and 4% tapioca egg white powder, buffalo meat sausages containing 7% tapioca starch and pork sausages also with 7% tapioca starch, respectively.

Based on the results of physico-chemical properties, chemical composition and sensory evaluation, formulation with 5% TF was selected over formulation containing 3% TF with the aim of replacing more meat portion to make it more cost effective. Further justification for this selection was that overall acceptability was high for 5% TF containing patties and protein and fat contents of this formulation was significantly (P<0.05) higher than patties containing 7% TF with no significant

Table 2: Effect of incorporation of different levels of tapioca flour on the sensory quality of patties (Mean ± SE)

Parameters	Control	3% Tapioca	5% Tapioca	7% Tapioca
Appearance	7.57±0.09	7.40±0.11	7.53±0.10	7.30±0.13
Flavor	7.20±0.12	7.30±0.11	7.33±0.10	7.03±0.13
Texture	7.23±0.13	7.27±0.15	7.17±0.08	7.03±0.13
Juiciness	7.20±0.11	7.20±0.12	7.17±0.11	6.90±0.18
Acceptability	7.37±0.11	7.17±0.11	7.43±0.10	7.10±0.13

Means with different superscripts in the same row differ significantly (P<0.05)

difference in pH of emulsion and pH of patties and emulsion stability between these two formulations.

Comparison of patties prepared by using food processor and bowl chopper

Physico-chemical properties of patties prepared by using food processer and bowl chopper: Cooking yield (%), pH of emulsion, emulsion stability (%) and pH of patties prepared by using food processer were 84.58±0.39, 6.11±0.00, 94.42±0.11 and 6.25±0.00, respectively. Corresponding values for the patties prepared with bowl chopper were 85.20±0.20, 6.10±0.00, 95.26±0.32 and 6.23±0.00, respectively (table 3). No significant (P>0.05) differences were observed in cooking yield (%), pH of emulsion and patties prepared in food processor and bowl chopper. Since the same recipe was used, the differences were not expected in pH of emulsion and patties only due to use of different machines. No significant difference in cooking yield (%) indicated that use of food processor and bowl chopper was comparable for making batter/emulsion for processing patties. However, the emulsion prepared in bowl chopper had significantly (P<0.05) higher emulsion stability (%) than that prepared using food processor. Mandal et al. (1996) prepared spent hen meat balls by mixing minced meat, fat and other ingredients in a Hobart mixer with similar values of pH and cooking yield (%). These results are similar to the observations of Kumar and Sharma (2005) who reported that spent hen meat patties prepared with 5, 10 and 15% pressed rice flour in bowl chopper had slightly higher emulsion

stability (%) and cooking yield (%). Mehta et al. (2013) reported that emulsion stability (%) values were slightly higher than cooking yield (%) when chicken patties are prepared using bowl chopper by incorporation of physillum husk in the formulation.

Sensory analysis of patties prepared by using food processer and bowl chopper: The sensory scores (table 4) of the spent hen meat patties prepared by using food processer and bowl chopper were desirable with the numerical scores of 7.40 to 7.63 for appearance, 7.43 to7.60 for flavour, 7.07 to7.63 for texture, 7.37 to 7.50 for juiciness and 7.43 to 7.67 for overall acceptability on 8-point hedonic scale. No significant (P<0.05) differences were recorded in appearance, flavor, juiciness and overall acceptability scores of patties prepared using food processor and bowl chopper. However, patties processed using bowl chopper had significantly (P<0.05) higher texture scores than those prepared using food processor which might be due to higher emulsion stability and the better efficiency of bowl chopper. This could be overcome by use of minced meat in the food processor. Mandal et al. (1996) reported desirable sensory quality spent hen meat balls prepared by mixing minced meat, fat and other ingredients in a Hobart mixer. These results are similar to Nagamallika et al. (2006) who observed no significant (P>0.05) differences in appearance, juiciness, tenderness and overall acceptability of spent hen meat patties prepared by using bowl chopper with different binders.

Table 3: Comparison of physico-chemical properties and chemical composition of patties prepared by using food processor and bowl chopper

Parameters	N	Food processor (Mean ± S.E)	Bowl chopper (Mean ± S.E)	T value	P value	Significant
Cooking yield (%)	3	84.58±0.39	85.20±0.58	0.88	0.42	NS
pH of emulsion	6	6.11±0.00	6.11±0.00	0.44	0.27	NS
pH of patties	6	6.25±0.006.	6.24±0.00	0.08	0.29	NS
Emulsion stability (%)	6	94.42±0.11a	95.26±0.32b	0.01	0.03	*
Moisture (%)	6	62.41±0.10b	61.96±0.06a	3.834	0.00	*
Protein (%)	6	19.27±0.07	19.27±0.08	0.030	0.97	NS
Fat (%)	6	9.23±0.08	9.15±0.06	0.828	0.42	NS

* Significant at P<0.05; NS – NonSignificant

Table 4: Comparison of sensory attributes of patties prepared by using of food processor and bowl chopper

Parameters	Food processor (Mean ± S.E)	Bowl chopper (Mean ± S.E)
Appearance	7.40±0.10	7.63±0.08
Flavor	7.43±0.11	7.60±0.11
Texture	7.07±0.11a	7.63±0.10b
Juiciness	7.37±0.12	7.50±0.10
Acceptability	7.43±0.11	7.67±0.08

* Sgnificant at P<0.05; NS – Not Significant

Economics of patties preparation

Formulation cost of emulsion and cost of patties was calculated taking into account only the cost of ingredients without considering the cost of machineries, operations and labour, etc.. It was found that increasing level of incorporation of TF decreased the cost of production proportionately. The production cost per Kg of patties also decreased with increased level of incorporation of TF (table 5) using food processor.

Table 5: Comparative profit of Giriraja breeder hen meat patties prepared by incorporating 3, 5, and 7% tapioca flour by replacing lean meat using food processor

Parameters	Control	T1	T2	T3
Cooking yield (%)	83.48	83.61	85.42	86.63
Production cost (Rs/kg)	221.47	221.12	216.44	213.41
Selling price (Rs/kg)	400	400	400	400
Profit (Rs/kg)	178.53	178.88	183.56	186.59
Profit (%)	80.61	80.89	84.66	87.43

* Sgnificant at P<0.05; NS – Not Significant

Patties with 5% tapioca flour had higher profit (88.91%) over patties containing 3% maida (87.53%). The comparative profit for formulation of one Kg of patties using food processor and bowl chopper (table 6) were 87.53 and 88.91% respectively. The production cost of patties prepared by using bowl chopper seems to be lower since the machine cost was not taken into account. Since food processor is available at a very low price (INR. 5000.00) compared to bowl chopper which may cost above INR.500,000 the initial investment requirement will be much less. Therefore, it will be highly economical to prepare patties using food processor for small scale household production for local market.

Table 6: Comparison of profit of Giriraja breeder hen meat patties prepared by using food processor and bowl chopper

Parameters	Food processor	Bowl chopper
Cooking Yield (%)	84.58	85.20
Production cost (Rs/kg)	213.29	211.74
Selling price (Rs/kg)	400	400
Profit (Rs/kg)	186.71	188.26
Profit (%)	87.53	88.91

* Sgnificant at P<0.05; NS – Not Significant

CONCLUSIONS

Based on the findings of the present study it may be concluded that the tapioca flour could be incorporated at the level of 5% without affecting the sensory qualities of chicken patties, which increased the cooking yield (%) and emulsion stability(%). The cost of patties prepared with increased levels of tapioca flour in the formulation by replacing the meat got reduced proportionately. It is economical to prepare patties using food processor over bowl chopper without affecting sensory and physico-chemical quality for small scale household production.

ACKNOWLEDGEMENT: The authors are grateful to the Dean, Rajiv Gandhi Institute of Veterinary Education and Research, Pondicherry for providing facilities for the conduct of the research work.

COMPETING INTEREST: The authors have no known competing interests.

ETHICS STATEMENT: Not applicable

REFERENCES

AOAC (1995) Official Methods of Analysis, 16th edition. Association of Official Analytical Chemists, Wahsington DC

Breuninger WF, Piyachomkwan K, Sriroth K (2009). Tapioca/ Cassava Starch: Production and Use, In:BeMiller J and Whistler R (Eds.), Starch (Third Edition)pp. 541-568

Bruyn D, Wong JT, Bagnold B, Pengelly P, Alders (2015) Family poultry, food and nutrition security CAB Rev. 10:9-11

Chatli MK, Sharma DK, Biswas AK, Sahoo J (2010). Quality characteristics of turkey meat patties formulated with tapioca starch. Indian J. Poult. Sci. 45:311-314

Chatterjee D, Brambila SG, Bowker BC, Zhuang H (2014). Effect of Tapioca Flour on physico-chemical quality measurements and sensory attributes of low fat chicken breast patties. US National Poultry Research Center. Athens, GA-30605, USA

Gawdaman G, KesavaRao V, Pal UK, Das CD, Premanand R (2009). Effect of incorporation of black gram paste on the quality of chicken meat patties. J. Meat. Sci. 6:27-33

Howeler R (2003). Cassava in Asia: Present situation and its future potential in agro- industries, summer institute, CTCRI, Trivandrum, pp58.

Hughes E, Mullen AM, Troy DJ (1998). Effect of fat level, tapioca starch and whey protein on frankfurters formulated with 5% and 12% fat. Meat Sci. 48:169-180

Keeton JT (1983). Effect of fat, NaCl and phosphate levels on the sensory properties of pork patties. J Food Sci. Technol. 48:591-597

Kumar RR, Sharma BD (2005). Evaluation of the efficacy of pressed rice flour as extender in chicken patties. Ind. J. Poult. Sci. 40:165-168

Mandal PK, Keshri RC, Bachhil VN, Kumar S (1996). Effect of cooking methods and storage on the quality of chicken meat balls. Int. J. Anim. Sci. 11: 225-227

Mehta NS, Ahlawat S, Sharma DP, Yadav S, Arora D (2013). Development and quality evaluation of chicken patties incorporated with psyllium husk. Haryana Vet. 52: 6-11

Mohammad NPU, Chatli MK and Sharma DK (2009). Efficacy of tapioca starch as a fat replacer in low fat buffalo meat patties. Buffalo Bull. 28:18-25

Murphy EW, Criner PE, Grey BC (1975). Comparison of methods for calculating retentions of nutrients in cooked food. J. Agric. Food Chem. 23: 1153-1157

Muthia D, Huda N, Ismail N and Easa AM (2012). The effects of egg white powder addition with tapioca and sago flours on physico-chemical and sensory properties of duck sausages. Int Food Res J, 19:1415-1421

Nagamallika E, Reddy KP, Reddy PM (2006). Effect of storage on physico-chemical, microbiological and sensory quality of chicken patties. Int. J. Poult. Sci. 41: 271-274

Naveena BM, Muthukumar M, Muthulakshmi L, Anjaneyulu ASR, Kondaiah N (2014). Effect of different cooking methods on lipid-oxidation and microbial quality of vacuum-packaged emulsion products from chicken. J. Food. Proc. Pres. 38: 39-47

Ponsingh R, Narendra BR, Ruban W, Apparao V (2011). Effect of tapioca starch on physico-chemical and sensory characteristics of buffalo meat sausages. J Food Technol. 9: 32-35

Raheem D, Chikwuma C (2001). Foods from cassava and their relevance to Nigeria and other African countries. Agric. Human Values 18: 383-390

Reddy BR, Mandal PK, Kasthuri S, Venugopal S, Pal UK (2018). Giriraja spent hen meat patties prepared by using food processor. J. Meat Sci. 13: 6 – 9

Ruban S, kalaikannan A, Babu N, Rao A, Nadeem F, Radhakrishnan (2008). Effect of tapioca starch on quality characteristics of pork sausages. J Meat Sci. 5:28-33

Russ N, Birgitta I, Zielbauer N, Marta G, Thomas AV (2016) Pre-gelatinized tapioca starch and its mixtures with xanthan gum and t-carrageenan. Food Hydrocoll. 56: 180-186

Serdaroglu M (2006). The characteristics of beef patties containing different levels of fat and oat flour. Int. J. Food Sci. Technol. 41: 147-153

Snedecor GW, Cochran WG (1994). Statistical methods. 6th edition. Oxford and IBH Publishing Co. New Delhi

Townsend WE, Witnauer LP, Riploff, Swift LE (1975). Communicated meat emulsions and differential thermal analysis of fat transition. Food Technol. 22: 319-323