Original Research

Evaluation of Certain Physico-Chemical and Sensory Qualities of Duck Meat Patties Incorporated with Black Gram Flour

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Abstract

A study was conducted to evaluate the effect of incorporation of different levels of black gram flour (BGF) on certain physico-chemical and sensory qualities of duck meat patties. Black gram is a rich source of protein and its incorporation in duck meat preparation is very much preferred by local people of Assam. Duck meat patties were prepared with three different levels of black gram flour (BGF) i.e. C_T (0% BGF), T_1 (5% BGF), T_2 (10% BGF) and T_3 (15% BGF). Among different formulations Emulsion stability (ES) was found to be the highest ($P < 0.01$) in T_3 formulation. The highest Cooking loss was found ($P < 0.01$) in control product (C_T). There was significant ($P < 0.01$) decrease in the WHC and pH of both the control and treated products after 5th day of storage. The highest a_w and TBA values were recorded in the control product. Irrespective of formulations the a_w decreased and TBA increased significantly ($P < 0.01$) during storage period. Sensory qualities of both control and treated products were found to be within acceptable limit up to 10 days of storage.

Key words: Black Gram Flour, Duck Meat, Emulsion, Patties, Physico Chemical and Sensory Qualities

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Introduction

Poultry meat is preferred over meat o C_T f other species not only due to its lower cost but also because of being an excellent source of animal protein. Duck (*Anasplatyrhynchos*) is one of the members of poultry family of economic significance. In India, the total poultry population is 729.2 million. Among the total poultry population in India, fowl share 95%, duck 3% and turkey & others 2%. Total duck population in the country is 23.5 million and duck occupies the second position next to chicken in poultry meat sector

(19th livestock census, 2012). Assam shares 3.73% (7th rank) poultry population among the other states of India (19th livestock census, 2012). In Assam, total poultry population is 27.21million and the total population of duck is 7.31million (Basic animal husbandry and fisheries statistics, 2014). Duck meat is widely accepted in Europe and South East Asian countries. In Assam and other North Eastern states of India duck meat has a very high demand. The aroma of duck meat is relatively stronger due to its higher lipid content. Compared to chicken and turkey, duck meat has higher lipid level and oxidative energy metabolism (Baeza, 2006).

Since, duck meat is tough and has a strong flavour, many people do not prefer it. To overcome this problem, nowadays different value added duck meat products are developed. Despite the high popularity and availability of duck meat particularly in the North-East region, studies on the use of duck meat in processed meat products are lacking. Due to rapid urbanization, speedy lifestyle, lack of time for cooking food at home, influence of electronic media and books have made the change in the meat eating habits of young generation resulting shift from hot meat consumption and to ready to eat type meat products. There is a wide variety of meat and meat products in the market viz. sausages, salamis, meat loaves, meat patties, frankfurters, tikka, kababs etc. Like chicken, verities of scrumptious, value added meat products such as patties, meatballs, sausages, nuggets, loaves etc. can also be prepared from duck meat to fulfil the aspiration of consumers and to increase the profit margin of producers and meat processors. Processing meat into emulsion-based products is desired to provide variety to the consumers, utilise meat from spent animals and for better marketability.

Materials and Methods

Raw Materials

Local ducks were collected from the Goat Research Station, Burnihat and were scientifically slaughtered in the mechanized poultry-dressing unit of the department of Livestock Products Technology, College of Veterinary Science, AAU, Khanapara, Guwahati- 781022. The carcasses were stored at refrigeration temperature (4±1°C) for overnight. On the following day, deboning was done and the lean and fat portions were separated. The required portion of meat was packed separately in food-grade polyethylene bags and then stored at 4 ± 1°C temperature for 24 hours. After 24 hours of storage, the deboned meat along with heart and gizzards were cut into small cubes of 3 cm size and then minced in a mechanical mincer through 4mm plate. All the important curing ingredients *viz*. salt (2%), sodium tri-polyphosphate (0.3%) and sodium nitrite (0.02%) were added to the minced meat and then thoroughly mixed and stored at 4±1°C for another 24 hours to facilitate proper curing. The black gram (*Vigna mungo*) was purchased from the nearby super-market and was washed, dried and finally ground to make flour in a mechanical grinder. The flour was hydrated and converted to paste (1:1 w/w hydration).

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Preparation of Duck Meat Patties

Different proportions of hydrated black gram flour i.e. 0%, 5%, 10% and 15% along with other seasonings i.e. spices/condiments were added to the minced duck meat and mixed thoroughly to prepare the meat emulsion. Duck patties were prepared by using a specific size of moulder and placing the meat batter in it. For the preparation of each patty, 75g of meat batter was moulded in a moulder with a height of 15 mm and diameter of 75 mm. The moulded raw patties were then placed on a stainless steel tray pre-smeared with vegetable oil to avoid sticking. Thereafter, cooking of the prepared patties were done in a preheated hot air oven at 185 ± 5°C until the internal temperature reached 75 ± 2°C, recorded at the geometrical centre of the patties using a probe thermometer. Then the patties were turned upside down and cooked for another 5 min for proper cooking. The cooked patties were cooled at 35 ± 5°C and subjected to sensory evaluation for different eating quality traits and the remaining patties were packed in LDPE pouches and stored under refrigeration for evaluation of different physico-chemical quality parameters.

Table 1: Formulation of ingredients for the preparation of control and treated duck meat patties (g/100g)

Ingredients	**C_T**	**T_1**	**T_2**	**T_3**
Meat (prime and non-prime cut)	67	62	57	52
Fat (skin + visceral organ)	15	15	15	15
Black gram (1:1 w/w hydration)	0	5	10	15
Spices	3	3	3	3
Condiments	5	5	5	5
Egg white	1.65	1.65	1.65	1.65
Ice cubes	5	5	5	5
Salt	2	2	2	2
Sugar	1	1	1	1
Baking soda	0.03	0.03	0.03	0.03
Sodium nitrite	0.02	0.02	0.02	0.02
Sodium tripolyphosphate	0.3	0.3	0.3	0.3
Total	100	100	100	100

The emulsion stability (ES) of duck meat patties was determined as per the method of Mongale *et al.* (1985). The pH was determined by pH meter (Model no. 780 pH meter), while water activity (a_w) was determined by Dew Point water activity meter (Model No. AQUALAB ATE). WHC of the duck meat patties were evaluated according to the technique described by Wardlaw *et al.* (1973) and TBA value as per the method of Witte *et al.* (1970). The sensory qualities of duck meat patties was determined by using a 9-point hedonic scale (Bratzler, 1971) (9 = extremely desirable, 1=extremely undesirable).

Results and Discussion

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Physico-Chemical Parameters

The results for ES were found to be increased along with the increased incorporation of black gram flour. The T_3 (15% BGF) recorded highest ES compared to the other three formulations *viz*. control (0% BGF), T_1 (5% BGF) and T_2 (10% BGF). This might be due to the gelatinizing property of starch component present in the extender, on heating, which stabilized the emulsion (Comer, 1979). Gelatinization of this starch improves the binding properties of meat protein (Puolanne and Ruusunen, 1983). Improvement of binding properties in meat products by addition of protein and starches of vegetable origin have also been reported by Price and Schweigert (1971); Sharma *et al*. (1988) and Comer *et al*. (1986). The T_3 products recorded significantly lower ($P < 0.01$) cooking loss as compared to other three formulations *viz.* Control (0% BGF), T_1 (5% BGF) and T_2 (10%). This might be due to the characteristic property of non-meat additives to bind the water ((Reitmer and Prusa, 1991) and also due to absorption of moisture from the emulsion by the extender resulting in lowering of moisture during cooking as observed by Reddy and Rao (1996) in chicken patties.

The p^H showed a non-significant but slightly increasing trend with increase in the levels of black gram flour. Such low increase in the p^H values of treated products might be due to the differences in the product formulations. This is in accordance with Yang *et al.* (2009) in duck meat sausage added with cereal flours and Bhat and Pathak (2011) in oven roasted chicken seekh-kababs incorporated with black bean paste. There was significant ($P < 0.01$) decrease in p^H value of duck meat patties of both control and treated products after 5^{th} day at refrigeration temperature. This might be due to the growth of Psychrophilic gram positive microorganisms, especially lactic acid producing organism (Shelef, 1975). Incze (1992) also stated that the decreased p^H in raw fermented meat products was due to production of organic acid mainly lactic acid during the carbohydrate fermentation. Biswas *et al*. (2006) reported similar findings in duck meat sausages stored at chilling temperature. The mean values recorded for WHC revealed significantly ($P < 0.01$) increasing trend from control to T_3 formulations. Such increase in the WHC might be due to the ability of extender to bind water, which leads to smaller release of water & fat and thereby improve binding property (Carballo *et al*., 1995; Pietrasik and Shand, 2003). The mean WHC of duck meat patties of all formulations decreased significantly ($P < 0.01$) after 5^{th} day along with the increase in the storage periods at refrigeration temperature. The results obtained in this study were in well agreement with the reports of Nagamallika *et al.* (2006) who reported a significant decreased of WHC in chicken patties during increased storage period at refrigeration temperature. The decrease in WHC might be due to the denaturation of myofibrillar protein which lowers the hydration capacity of proteins and loosening up of microstructure of muscles allowing more water to be entrained.

The mean water activity (a_w) values recorded for duck meat patties decreased in the black gram flour treated formulations as compared to control. Such progressive decrease of a_w in the treated products might be

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attributed to the incorporation of increasing levels of black gram flour. However, the a_w of duck meat patties, in both control and treated groups decreased significantly ($P < 0.01$) from 1st to 15th day of storage at refrigeration temperature. This might be due to growth of microorganisms, which utilized water for multiplication (Dharmaveer *et al.*, 2007). The results obtained in this study were in accordance with Rajkumar and Berwal (2004) in chevon patties (Andres *et al.*, 2006) in low-fat chicken sausages stored under refrigeration for about 21 days. A progressive but non-significant decrease in TBA values was observed in the treated products compared to the control. This lower TBA values in the treated formulations might be related to the reduction of the level of fat by incorporation of increase level of black gram flour. However, TBA value increased significantly ($P < 0.01$) in both the control and treated formulations, with increased storage period. It might be due to oxidation of fat over a period of storage (Sarbanes *et al*., 2005), besides, production of volatile metabolites in the presence of oxygen during packaging (Jo *et al*., 1999). The results of this study were in well agreement with Devalakshmi *et al.* (2010) in chicken meat chips extended with cooked and mashed potato, bengal gram flour and black gram flour stored at ambient and refrigeration temperature and Biswas *et al.* (2011) in duck meat patties during increase in storage period at ambient and refrigeration temperature.

Table 2: Emulsion stability & cooking loss of control and black gram treated duck meat patties

Parameters	Control	Incorporation of black gram flour		
		T_1 (5%)	T_2 (10%)	T_3 (15%)
ES (ml/g)	1.47a ± 0.08	1.30a ± 0.13	0.81b ± 0.13	0.57 b ± 0.10
Cooking loss (%)	24.03a ± 0.70	20.75a± 0.82	16.03b ±1.56	12.10b±1.84

Table 3: Physico-chemical qualities of control and black gram treated duck meat patties

Treatment / Days		WHC (ml/100g)	pH	a_w	TBA (mg malonaldehyde/kg)
C_T	1	$^{A}55.79^{a} \pm 1.73$	$^{A}6.03^{a} \pm 0.04$	$^{A}0.945^{a} \pm 0.001$	$^{D}0.346^{a} \pm 0.038$
	5	$^{A}56.87^{b} \pm 1.43$	$^{A}6.07^{a} \pm 0.03$	$^{B}0.939^{a} \pm 0.00$	$^{C}0.507^{a} \pm 0.035$
	10	$^{A}54.7^{a} \pm 1.24$	$^{B}5.83^{a} \pm 0.04$	$^{C}0.929^{a} \pm 0.002$	$^{B}0.703^{a} \pm 0.032$
	15	$^{A}53.54a \pm 0.98$	$^{B}5.79^{a} \pm 0.03$	$^{D}0.921^{a} \pm 0.001$	$^{A}0.903^{a} \pm 0.011$
T_1	1	$^{A}56.99^{a} \pm 1.52$	$^{A}6.09^{a} \pm 0.04$	$^{A}0.943^{ab} \pm 0.001$	$^{D}0.336^{a} \pm 0.038$
	5	$^{A}57.99^{b} \pm 1.43$	$^{A}6.10^{a} \pm 0.05$	$^{A}0.938^{ab} \pm 0.001$	$^{C}0.497^{a} \pm 0.034$
	10	$^{A}55.6^{a} \pm 1.26$	$^{B}5.86^{a} \pm 0.04$	$^{B}0.927^{a} \pm 0.003$	$^{B}0.692^{a} \pm 0.032$
	15	$^{A}54.7^{a} \pm 1.31$	$^{B}5.79^{a} \pm 0.02$	$^{C}0.914^{b} \pm 0.003$	$^{A}0.893^{a} \pm 0.011$
T_2	1	$^{A}58.74^{a} \pm 1.61$	$^{A}6.15^{a} \pm 0.05$	$^{A}0.940^{bc} \pm 0.002$	$^{D}0.333^{a} \pm 0.038$
	5	$^{A}59.6^{ab} \pm 0.88$	$^{A}6.16^{a} \pm 0.05$	$^{A}0.935^{bc} \pm 0.002$	$^{C}0.495^{a} \pm 0.034$
	10	$^{A}57.07^{a} \pm 1.77$	$^{B}5.91^{a} \pm 0.05$	$^{B}0.926^{a} \pm 0.003$	$^{B}0.689^{a} \pm 0.032$
	15	$^{A}55.63^{a} \pm 1.49$	$^{B}5.82^{a} \pm 0.03$	$^{C}0.911^{b} \pm 0.003$	$^{A}0.890^{a} \pm 0.011$
T_3	1	$^{A}60.52^{a} \pm 1.64$	$^{A}6.18^{a} \pm 0.04$	$^{A}0.937^{c} \pm 0.002$	$^{D}0.331^{a} \pm 0.008$
	5	$^{A}62.08^{a} \pm 0.85$	$^{A}6.19^{a} \pm 0.03$	$^{B}0.931^{c} \pm 0.002$	$^{C}0.491^{a} \pm 0.034$
	10	$^{A}59.38^{a} \pm 1.80$	$^{B}5.93^{a} \pm 0.04$	$^{C}0.920^{a} \pm 0.00$	$^{B}0.686^{a} \pm 0.032$
	15	$^{A}57.79^{a} \pm 1.85$	$^{B}5.85^{a} \pm 0.03$	$^{D}0.911^{b} \pm 0.001$	$^{A}0.887^{a} \pm 0.011$

Mean with dissimilar superscript (capital letter) in a column differ significantly (P < 0.01); Mean with dissimilar superscript (small letter) in a row differ significantly (P < 0.01)

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Sensory Attributes

Colour

The colour scores of duck meat patties decreased significantly (P < 0.01) along with the increasing levels of black gram flour in the treated formulations. This might be due to increased level of black gram flour in the treated products, which reduced the dark colour of duck meat by diluting the meat pigment. The findings of this study corroborate well with the reports of Kenawi *et al.* (2009) in buffalo meat patties containing 5% of both low fat soy flour and mung bean powder. The colour scores of both control and treated formulations decrease significantly (P < 0.01) with increased of the storage period which might be due to pigment and lipid oxidation resulting in non-enzymatic browning. Similar significant (P < 0.01) decrease in colour scores of duck patties stored at refrigeration temperature was reported by Biswas *et al.* (2011) and Malav *et al.* (2014) in chicken meat blocks extended with lentil flour at refrigerated storage.

Flavour

Slight decrease in flavour score of duck meat patties along with the incorporation of increased levels of black gram flour was recorded; however, the values were non-significant. This decrease might be due to lowering of fat content replaced by black gram flour and also might be due to dilution of meaty flavour with increase in the level of extender (Bhat *et al*., 2012; Malav *et al*., 2013). A significant decrease in flavour scores (P < 0.01) in the both control and treated formulations was also observed along with increase in the duration of storage. This might be due to increase malonaldehyde formation due to oxidation of fat which has detrimental effect on the flavour and firmness of the product (Millar *et al*., 1980) and also might be due to oxidation of fat and microbial growth (Suresh *et al.*, 2003). The observations of Biswas *et al*. (2011) and Malav *et al.* (2014) were in agreement with the present results.

Juiciness

Non-significant decrease of juiciness score for duck meat patties along with increased levels of incorporation of black gram flour was observed which might be because of progressive lowering of fat and moisture with simultaneous increase in the level of black gram flour. Similar result was reported by Bhat and Pathak (2011) in chicken seekh kababs incorporated with black bean. The result of present study was well in agreement with the study of Bhat *et al*. (2012), Malav *et al.* (2013) and Motamedi *et al.* (2015). The results showed that with increase in storage period, the score for juiciness of patties decreased significantly (P < 0.01). This might be ascribed to moisture loss during storage (Reddy and Rao, 1997) and might be due to the use of low-density polyethylene packaging materials, which were permeable to water vapour (Biswas *et al.*, 2011).

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Texture

The texture score for duck meat patties decreased along with increasing levels of incorporation of black gram flour. Such decrease in texture scores with higher levels of extender may be due to replacement of structural meat proteins by extender (Verma *et al*., 1984). Similar result was reported by Choudhury & Ledward (1988) in beef sausages with black gram and Bhat *et al.* (2012) in chicken seekh kababs with cowpea. With increase in the storage period the score for texture of duck meat patties decreased significantly ($P < 0.01$). Similar result were also reported by Biswas *et al*. (2011) and Malav *et al.* (2014) in duck sausage and chicken meat blocks extended with lentil flour respectively.

Tenderness

There was non-significant decrease for tenderness score along with the increasing levels of black gram flour. Such decreased score for tenderness might be due to reduction of fat and increased incorporation of black gram flour in the treated products. Similar result was reported by Verma *et al.* (2012) in chicken nuggets prepared with added chickpea hull flour. A significant ($P < 0.01$) decrease in tenderness score due to increase in storage periods. This might be due to loss of moisture from the product during prolonged storage (Reddy and Rao, 1997). Biswas *et al.* (2011) reported similar result in duck meat patties stored at ambient and refrigeration temperature. Malav *et al.* (2014) also reported similar findings in restructured chicken meat blocks extended lentil flour respectively.

Table 4: Sensory quality parameters of control and black gram treated duck meat patties

Treatment / Days		Colour	Flavour	Juiciness	Texture	Tenderness	Overall Acceptability
C_T	1	$_{A}8.18_{a} \pm 0.21$	$^{A}7.63^{a} \pm 0.31$	$^{A}7.58^{a} \pm 0.30$	$^{A}7.66^{a} \pm 0.28$	$^{A}7.73^{a} \pm 0.31$	$_{A}7.81_{a} \pm 0.21$
	5	$_{A}8.07_{a} \pm 0.20$	$^{A}7.50^{a} \pm 0.31$	$^{A}7.48^{a} \pm 0.31$	$^{A}7.52^{a} \pm 0.29$	$^{A}7.55^{a} \pm 0.31$	$_{A}7.70_{a} \pm 0.21$
	10	$_{AB}7.83_{a} \pm 0.19$	$^{A}7.23^{a} \pm 0.33$	$^{A}7.10^{a} \pm 0.30$	$^{A}7.06^{a} \pm 0.29$	$^{A}7.09^{a} \pm 0.35$	$_{AB}7.42_{a} \pm 0.21$
	15	$_{B}7.40_{a} \pm 0.15$	$^{A}6.84^{a} \pm 0.38$	$^{A}6.68^{a} \pm 0.33$	$^{A}6.58^{a} \pm 0.28$	$^{A}6.58^{a} \pm 0.33$	$_{B}6.92_{a} \pm 0.21$
T_1	1	$_{A}7.71_{a} \pm 0.20$	$^{A}7.77^{a} \pm 0.25$	$^{A}7.64^{a} \pm 0.11$	$^{A}7.47^{a} \pm 0.18$	$^{A}7.73^{a} \pm 0.20$	$_{A}7.55_{a} \pm 0.14$
	5	$_{A}7.52_{ab} \pm 0.21$	$^{A}7.49^{a} \pm 0.22$	$^{AB}7.40^{a} \pm 0.06$	$^{AB}7.35^{a} \pm 0.17$	$^{A}7.47^{a} \pm 0.19$	$_{A}7.43_{a} \pm 0.14$
	10	$_{A}7.36_{ab} \pm 0.19$	$^{AB}7.17^{a} \pm 0.24$	$^{B}7.10^{a} \pm 0.10$	$^{BC}6.89^{a} \pm 0.17$	$^{B}6.96^{a} \pm 0.12$	$_{AB}7.09_{a} \pm 0.15$
	15	$_{A}7.04_{a} \pm 0.27$	$^{B}6.67^{a} \pm 0.27$	$^{C}6.64^{a} \pm 0.15$	$^{C}6.52^{a} \pm 0.17$	$^{C}6.42^{a} \pm 0.11$	$_{B}6.66_{a} \pm 0.19$
T_2	1	$_{A}7.59_{a} \pm 0.22$	$^{A}7.76^{a} \pm 0.23$	$^{A}7.44^{a} \pm 0.35$	$^{A}7.37^{a} \pm 0.11$	$^{A}7.70^{a} \pm 0.28$	$_{A}7.52_{a} \pm 0.29$
	5	$_{A}7.44_{b} \pm 0.22$	$^{A}7.57^{a} \pm 0.25$	$^{A}7.38^{a} \pm 0.35$	$^{A}7.28^{a} \pm 0.11$	$^{AB}7.45^{a} \pm 0.22$	$_{A}7.42_{a} \pm 0.29$
	10	$_{A}7.13_{b} \pm 0.22$	$^{A}7.30^{a} \pm 0.25$	$^{A}7.06^{a} \pm 0.34$	$^{A}6.86^{a} \pm 0.15$	$^{B}6.96^{a} \pm 0.18$	$_{A}7.11_{a} \pm 0.29$
	15	$_{A}6.95_{a} \pm 0.31$	$^{B}6.30^{a} \pm 0.29$	$^{A}6.67^{a} \pm 0.37$	$^{B}6.49^{a} \pm 0.11$	$^{C}6.19^{a} \pm 0.07$	$_{A}6.64_{a} \pm 0.27$
T_3	1	$_{A}7.31_{a} \pm 0.18$	$^{A}7.42^{a} \pm 0.15$	$^{A}7.26^{a} \pm 0.20$	$^{A}7.42^{a} \pm 0.17$	$^{A}7.45^{a} \pm 0.33$	$_{A}7.48_{a} \pm 0.33$
	5	$_{A}7.20_{b} \pm 0.18$	$^{A}7.30^{a} \pm 0.15$	$^{A}7.14^{a} \pm 0.20$	$^{A}7.31^{a} \pm 0.16$	$^{A}7.29^{a} \pm 0.33$	$_{A}7.37_{a} \pm 0.33$
	10	$_{A}7.00_{b} \pm 0.19$	$^{AB}6.96^{a} \pm 0.15$	$^{AB}6.69^{a} \pm 0.22$	$^{A}6.88^{a} \pm 0.19$	$^{A}6.83^{a} \pm 0.32$	$_{A}6.98_{a} \pm 0.32$
	15	$_{A}6.73_{a} \pm 0.18$	$^{B}6.53^{a} \pm 0.17$	$^{B}6.28^{a} \pm 0.19$	$^{A}6.29^{a} \pm 0.23$	$^{A}6.27^{a} \pm 0.27$	$_{A}6.56_{a} \pm 0.28$

Overall Acceptability

The overall acceptability score decreased along with increased levels of incorporation of hydrated black gram flour. This decreased score for overall acceptability might be due to the lower scores recorded for

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colour, flavour, juiciness, texture and tenderness qualities due to the addition of black gram flour. Similar results were reported by Bhat and Pahak (2012) in oven roasted chicken seekh kababs extended with cowpea flour and Malav *et al.* (2013) in chicken meat blocks with lentil flour. A significant ($P < 0.01$) decrease in overall-acceptability of duck meat patties with increase in storage periods was observed which might be primarily due to the reduction of flavour and colour scores as a result of development of some volatile flavour component in consequence to the oxidation of fat, besides, decreased moisture content, bacterial growth etc. Biswas *et al*. (2011) also reported the reduction of overall acceptability of duck meat patties with increase in storage period at ambient and refrigeration temperature.

Conclusion

The results of this study revealed that duck meat patties incorporated with black gram flour at 15% level recorded highest yield and ES. In this present study an increasing trend was observed in ES and cooking loss was found to be decrease with increase incorporation of black gram flour. It may be concluded that although the control product had the highest sensory score, duck meat patties could be prepared satisfactorily by replacing the lean duck meat with upto 15 per cent levels of hydrated (1:1 w/w) black gram flour in the patties, without adversely affecting the various meat quality traits.

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