EFFECT OF DIFFERENT LEVELS OF GLYCEROL ON PHYSICO-CHEMICAL AND SENSORY CHARACTERISTICS OF BARBECUED CHICKEN

P. Gunasekaran[1], T. Sathu[2], P. Kuttinarayanan[3], V.N.Vasudevan[4], Kuleswan Pame[5], A. Irshad[4] and S. Prajwal[6]
Department of Livestock Products Technology, College of Veterinary and Animal Sciences, Mannuthy, Thrissur - 680651, Kerala.

Received- 29.06.2016
Accepted- 02.07.2016

Abstract

*A study was conducted to optimize the level of humectant glycerol (HG) as a hurdle(i.e., a_w hurdle)for the preparation of barbecued chicken. In this study three different concentration of HG based on green weight of chicken was used as desorption solution viz., Treatment T_1-1.0%, Treatment T_2-2.0%and Treatment T_3-3.0%. Different physico-chemical parameters evaluated were pH, water activity (a_w), cooking yield, moisture, protein, fat, ash contents, Hunter L*a*b* values and sensory attributes. With increase in concentration of HG in desorption solution significant (p<0.05) reduction in a_w and significant (p<0.05) increase in fat and ash content of the products was noted. The desorption of barbecued chicken with HG solution had no significant effect on lightness (L^*) and redness (a^*) value. However, T_2 had a significantly (p<0.05) lower yellowness (b^*) value among treatments. The addition of HG in the barbecued chicken significantly (p<0.05) improved the juiciness, texture and overall acceptability score. Among all treatments T_2 showed significantly (p<0.05) lower a_w, comparatively higher cooking yield and significantly (p<0.05) higher overall acceptability. Thus, it can be inferred that barbecued chicken treated with 2 per cent HG desorption solution had better physico-chemical and sensory characteristics compared to other treatments and control.*

Key words: humectant, glycerol, a_w, quality characteristics, barbecued chicken.

In India, poultry production has registered a magnificent growth in the last two decades. However, the poultry processing industry, especially value added poultry product sector has not been gaining momentum as that of the product front. Inadequate processing technology and lack of cold chain facilities are the main reasons for the impairment of progress in this sector, especially in our traditional meat products like tandoori chicken, kofta, Indian barbecued chicken etc.

Barbecued chicken is a popular traditional meat product with good acceptability all over the world and its perishability is

1. *MVSc Scholar*
2. *Assistant Professor and corresponding author*
3. *Professor and Head (Retd.)*
4. *Assistant Professor*
5. *Assistant Professor, Department of Livestock Products Technology, International Institute of Veterinary Education & Research, Hisar*
6. *Ph.D. Scholar*

Email: sathu@kvasu.ac.in

primarily due to microbial spoilage at ambient temperature. Hurdle technology is the use of different preservation techniques in a combined manner to enhance the sensory qualities, microbial stability as well as nutritional and economic properties (Leistner, 2000). The main objective of hurdle technology is to prevent microbial spoilage and food poisoning by using a combination of hurdles like decreased pH, lower a_w, using preservatives etc. at sub minimal level thereby increasing the shelf life of the products taking care to maintain or improve the sensory properties.

Decreasing the energy requirement for food preservation and improving the safety of preserved foods are the two factors to be addressed, especially in underdeveloped and developing countries where there is acute shortage of power. Glycerol is commonly used as a humectant to lower the water activity and to improve the sensory qualities (Brimelow, 1985). The objective of the present study was to standardise the processing technology for barbecued chicken and to optimize the level of humectant (i.e., a_w hurdle) in barbecued chicken using glycerol.

Materials and Methods

Raw materials

Broiler chicken of 1.5 to 1.8 kg live body weight procured from the local market, humanely slaughtered and dressed under hygienic conditions at Meat Technology Unit, Mannuthy was used for the study. Refined sunflower oil (Sundrop) was used for frying of spice mix. The condiment mixture was prepared as and when required by blending chopped onion, ginger and garlic (1:1:1 w/w) to the consistency of a fine paste. The spice mix used in the experiment was prepared as per the formulation developed in Meat Technology Unit. Food grade glycerol purchased from the Genesys Inc. Tamil Nadu, India was used as humectant.

Preparation of curing solution

The curing solution was prepared by dissolving the curing ingredients at the following concentrations; sodium chloride 3.8 per cent, sodium-tri-polyphosphate 3 per cent and sodium nitrite 900 ppm in high purity cold water. The strength of the brine was maintained at 24°C and was recorded using a salinometer (Tel-Tru, Tamil Nadu, India).

Preparation of humectant solution

Based on experimental design three different levels of Glycerol (HG), *viz.,*1.0, 2.0 and 3.0 per cent of green weight of the dressed chicken carcasses was weighed and dissolved in cold water (chicken: cold water=1:1.5) for desorption.

Analytical procedures

The pH was determined by using combined electrode digital pH meter (μ pH system 362, Systronics, India) as per procedure of Troutt *et al.* (1992). The weights of barbecued chicken before and after cooking were recorded and the cooking yield was expressed in percentage as per procedure of Berry and Wergin (1992).

$$\text{Cooking yield (\%)} = \frac{\text{Final product weight} \times 100}{\text{Green weight of chicken}}$$

Water activity of the barbecued chicken was determined by using Lab swift a_w meter (Novasina, Switzerland). Colour of the barbecued chicken sample was determined objectively as per Navneet and Shitij (2011) using Hunter Lab Mini Scan XE Plus Spectrophotometer (Hunter Lab, Virginia, USA) with diffuse illumination. The moisture, protein, fat and ash content of the barbecued chicken were determined by standard procedure (AOAC,1995).

Organoleptic evaluation

Sensory attributes of the barbecued chicken were assessed organoleptically using 8-point Hedonic scale score card (AMSA, 1983) with the help of seven semi-trained taste panelists drawn from the Department of Livestock Products Technology, Mannuthy, Thrissur. The barbecued chicken was reheated at 100°C for 20 mins and then served warm to the panelists with three-digit code numbers to the samples. The average of the individual

scores was taken as the score for the particular attribute.

Statistical analysis

The experiment was replicated four times and the data obtained for physico-chemical and sensory evaluation of different products was statistically analyzed as per Snedecor and Cochran (1994) using SPSS software version 21.

Results and Discussion

Physico-chemical characteristics and proximate composition

The results with respect to physico-chemical characteristics and proximate composition of barbecued chicken are presented in the Table 2.

The product pH and cooking yield did not differ significantly in barbecued chicken treated with glycerol desorption solution and agrees with result reported by Singh *et al.* (2014) in chicken lollipop incorporated with glycerol as humectant. The a_w of T_2 and T_3 was significantly ($p<0.05$) lower when compared to T_1 and control, this may be due to ability of HG to reduce a_w in barbecued chicken. Malik and Sharma (2010) also observed a significant decrease in a_w in shelf stable buffalo meat chunks treated with 9.5 per cent desorption solution of glycerol. The moisture content of T_1 was significantly ($p<0.05$) lower than other treatments. The moisture was significantly ($p<0.05$) higher in barbecued chicken processed with two per cent HG. No significant difference was noted between C and T_1. However, Malik and Sharma (2010) reported significant ($p<0.05$) decrease in moisture percentage of buffalo meat chunks on desorption with glycerol solution. The inclusion of HG solution had no significant effect on the protein percentage of barbecued chicken. The fat and ash percentage of T_3 was significantly ($p<0.05$) higher than all other formulations. The result showed an increase in the fat and ash percentage with increase in the concentration

Table 1. Formulary for the preparation of barbecued chicken

Ingredients	C (%)	T_1 (%)	T_2 (%)	T_3 (%)
Chicken	100	100	100	100
Glycerol (green wt. of the meat)	--	1	2	3
Coriander powder	1	1	1	1
Small onion	1	1	1	1
Garlic	1	1	1	1
Ginger	1	1	1	1
Lemon juice	1	1	1	1
Kashmiri chilli powder	1	1	1	1
Turmeric powder	0.5	0.5	0.5	0.5
Chilli powder	0.5	0.5	0.5	0.5
Black pepper powder	0.3	0.3	0.3	0.3
Cumin powder	0.2	0.2	0.2	0.2
Cinnamon + Clove powder	0.2	0.2	0.2	0.2
Oregano powder	0.01	0.01	0.01	0.01
Cardamon powder	0.01	0.01	0.01	0.01
Salt (green wt. of the meat)	1.1	1.1	1.1	1.1
Curd	2	2	2	2

*above the quantity of the formulation added over and above treatment (control) barbecued chicken.
C– Control (Without glycerol)
T1 – Treatment1 (1% Glycerol desorption solution)
T2 – Treatment2 (2% Glycerol desorption solution)
T3 – Treatment3 (3% Glycerol desorption solution)

of HG in desorption solution. Okonkwo *et al.* (1992) observed significant increase in fat and ash content in intermediate moisture smoked beef on treating with glycerol.

Table 2. Effect of different levels of glycerol on physico-chemical characteristics and proximate composition of the barbecued chicken

Parameters	C	T_1	T_2	T_3
pH	6.15±0.02	6.10±0.02	6.16±0.03	6.14±0.02
Water activity (a_w)	0.86±0.01^{b}	0.86±0.01^{b}	0.83±0.01^{a}	0.81±0.01^{a}
Cooking yield (%)	61.75±0.81	58.45±1.83	61.78±1.44	59.13±1.33
Moisture (%)	56.52±0.85^{ab}	55.52±0.72^{a}	60.17±0.58^{c}	58.63±1.36^{bc}
Protein (%)	15.62±0.21	15.82±0.20	15.62±0.18	15.82±0.15
Fat (%)	8.70±0.12^{a}	9.31±0.22^{a}	9.42±0.25^{ab}	10.10±0.34^{b}
Ash (%)	1.61±0.10^{a}	1.86±0.03^{ab}	1.79±0.03^{a}	2.04±0.05^{b}

Mean ± SE with same superscripts in a row does not differ significantly (P<0.05)
C – Control Without glycerol)
T_1 – Treatment 1 (1% Glycerol desorption solution)
T_2 – Treatment 2 (2% Glycerol desorption solution)
T_3 – Treatment 3 (3% Glycerol desorption solution)

Table 3. Effect of different levels of glycerol on the colour of barbecued chicken

Parameters	C	T_1	T_2	T_3
L* (lightness)	26.94±1.10	26.25±0.80	28.20±0.56	26.89±1.04
a* (redness)	16.96±0.61	17.19±0.58	16.47±0.39	18.31±0.53
b* (yellowness)	20.26±2.28^{ab}	22.71±1.44^{b}	16.47±0.39^{a}	21.46±0.90^{b}

Mean ± SE with same superscripts in a row does not differ significantly (P<0.05)
C– Control (Without glycerol)
T_1 – Treatment 1 (1% Glycerol desorption solution)
T_2 – Treatment 2 (2% Glycerol desorption solution)
T_3 – Treatment 3 (3% Glycerol desorption solution)

Table 4. Effect of different levels of glycerol on the sensory attributes* of barbecued chicken

Parameters	C	T_1	T_2	T_3
Colour and appearance	6.50±0.16	6.37±0.14	6.60±0.14	6.73±0.11
Flavour	6.03±0.14	6.00±0.15	6.27±0.12	6.33±0.13
Texture	6.37±0.11^{ab}	6.07±0.14^{a}	6.53±0.13^{b}	6.57±0.16^{b}
Juiciness	5.63±0.13^{a}	5.57±0.16^{a}	6.13±0.17^{b}	6.40±0.19^{b}
Saltiness	5.87±0.17	5.90±0.18	6.10±0.13	6.20±0.13
Spiciness	6.03±0.15	6.00±0.16	6.13±0.13	6.33±0.11
Overall acceptability	6.03±0.15^{a}	5.86±0.16^{a}	6.80±0.11^{b}	6.66±0.11^{b}

Mean ± SE with same superscripts in a row does not differ significantly (P<0.05)
*Based on eight-point Hedonic scale (8 = extremely desirable; 1=extremely undesirable).
C– Control (Without glycerol)
T_1 – Treatment 1 (1% Glycerol desorption solution)
T_2 – Treatment 2 (2% Glycerol desorption solution)
T_3 – Treatment 3 (3% Glycerol desorption solution)

Colour

The barbecued chicken samples colour characteristics were measured in terms of L^* a^* and b^* values and results are given in the Table 3. The lightness (L^*) values varied from 26.94-28.20 and the redness (a^*) values varied from 16.96-18.31 for different groups. The lightness and redness values did not differ significantly in both control (C) and treatment groups (T_1, T_2 and T_3) and is not in agreement with studies of Okonkwo*et al.*(1992) who reported that infusion of glycerol darkened the intermediate moisture meat. The yellowness (b^*) values varied from 20.26-21.46. T_2 had significantly ($p<0.05$) lower yellowness value among the treatments and was comparable with control.

Organoleptic evaluation

The scores obtained for various sensory attributes are given in the Table 4. No significant difference was observed for colour, appearance and flavour scores of HG treated and the control barbecued chicken. However, Ledward (1981) reported that higher level of humectant, decrease the flavour in the finished meat products. The texture and juiciness scores for T_2 and T_3 was significantly ($p<0.05$) higher than other formulations. This may be due to higher moisture and fat content and better water holding capacity in samples desorbed with glycerol solution at 2 per cent level and above. Karthikeyan *et al.* (2000) reported no significant difference for juiciness score in caprine keema between control and samples treated with humectants. Textural difference was not well marked among treatments but significantly ($p<0.05$) higher score in HG treated samples may be due to higher moisture level. The sensory score of the product did not differ significantly ($p<0.05$) for saltiness and spiciness. The similar result was reported by Malik and Sharma (2010) in shelf stable buffalo meat chunks infused with different levels of glycerol. The overall acceptability score ranged from 5.86 - 6.80 with maximum acceptability score among treatments was obtained for T_2 and significantly ($p<0.05$) lowest score for T_1. Monica and Adoracion (2014) reported that among 2.5, 5.0 and 7.5 per cent glycerol concentration, tocino prepared with added 2.5 per cent of glycerol as humectant was most acceptable in terms of texture, flavour and overall acceptability.

Conclusions

From the study it can be inferred that barbecued chicken desorbed with two per cent glycerol solution had higher cooking yield, lower a_w, improved juiciness, texture and sensorially most acceptable among all treatments and control.

Figure 1. Flow chart for preparation of barbecued chicken

↓

Ready to cook chicken (1.5 to 1.8 kg)

↓

Injection of brine solution (10% of the dressed chicken)

↓

Brine injected chicken immersedfor 12 hrs. in 2% Glycerol solution at 4°C

↓

Draining of excess solution (20mins)

↓

Marination of chicken with spice mix formula mentioned. Chicken kept in chiller for 3-4 hours (Before marination spice mix were fried in vegetable oil at 80-100°C for 5 minutes)

↓

Intermittent vacuum tumbling for 45 mins (15mins tumbling +15mins rest + 15mins tumbling)

↓

Cooking at 150°C for 1hr (Electric *tandoori* oven)

↓

Sensory and physico-chemical evaluation

References

AMSA, 1983. Guidelines of sensory, physical and chemical measurements in ground beef. *Recip. Meat Conf.Proc.* **36**: 221-*228.*

AOAC, 1995. Meat and meat products. In *Official Methods of Analysis of Official Analytical Chemist*. (15th Ed.). Association of official analytical chemict. Inc. Arlington. Virginia. Pp. 931-948.

Berry, B.W. and Wergin, W.P. 1992. Modified pregelatinized potato starch in low-fat ground beef patties. *J. Muscle Foods*. **4:** 305-320.

Brimelow, C.J. B. 1985. In: Simatos, D. and Multon J.L. (eds.), *Properties of water in foods*. Martinus Nijhoff Publishers, Dordrecht, The Netherlands.

Karthikeyan, J., Kumar, S., Anjaneyulu, A. S. R. and Rao, K. H. 2000. Application of hurdle technology for the development of Caprine keema and its stability at ambient temperature. *Meat Sci.*, **54**: 9-15.

Ledward, D. A. 1981. Intermediate moisture meats. In: Lawrie R. (eds,) *Developments in Meat Science* (2nd Ed.) 159-194. London: Applied Science Publishers.

Leistner, L. 2000. Basic aspects of food preservation by hurdle technology. *Int. J. of Food Microbiol.* **55**: 181-186.

Malik, A. H. and Sharma, B. D. 2010. Comparison of hurdle treatments for buffalo meat. *Int. J. Food Sci. Technol*. **45**: 1552-1563.

Monica, M. and Adoracion, B. 2014. Effects of different humectants in the physico-chemical properties of ready-to-eat (RTE) Tocino. Presented at the DLSU Research Congress March 6-8, De La Salle University, Manila, Philippines.

Navneet, K., and Shitij, K. 2011. Development of carrot pomace and wheat flour based cookies. *Pure Appl. Sci. Technol*. **1**: 4-10.

Okonkwo, T. M., Obanu, Z. A. and Ledward, D. A. 1992. Characteristics of some intermediate moisture smoked meats. *Meat Sci.* **31**: 135-145.

Singh, V. P., Vikas, P., Nayak, N. K. and Goswami, M. 2014. Application of hurdle concept in development and shelf life enhancement of chicken lollipop. *Int. J. of Curr. Microbial. Appl. Sci.* ISSN: 2319-7706. **3**: 355-361.

Snedecor, G.W. and Cochran, W.G. 1994. Statistical methods. (8th Ed.). The Iowa state university press, Ames, Iowa, USA.

Troutt, E.S., Hunt, M.C., Johnson, D.E., Claus, J.R., Kastner, C.L. and Kroff, D.H. 1992. Characteristics of low fat ground beef containing texture modifying ingredients. *J. Food Sci*. **57**: 19-24. ■