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Effect of Vacuum Tumbling on Chemical and Microbial Quality of Tandoori Chicken

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ABSTRACT

The study was aimed to assess the chemical and microbial quality of tandoori chicken prepared from native chicken meat by marinating the chicken breast meat at different vacuum tumbling time exposures giving rise to five treatments viz. T_0 (Control-No tumbling), T_1 (30 minutes), T_2 (1 hour), T_3 (2 hours) and T_4 (3 hours). After marination, the samples were immediately cooked for 10-20 minutes at 250°C to prepare tandoori chicken breast meat. The whole design was replicated twelve times. The results revealed a significantly higher pH of product in treatment T_3. No effect of vacuum tumbling was observed on Thio-barbituric Acid (TBA) value, Tyrosine value (TV), Total Plate Count (TPC) and Yeast & Mould Count (YMC). However, significant increase of pH, TBA value and TV with significant decrease in TPC of product was observed as a result of high temperature cooking. Significantly highest sensory scores and profit per kg were observed in treatment T_3 and lowest in T_0 (Control) with progressive increase from T_0 to T_3. Thus, marination at 2 hours vacuum tumbling followed by 10-20 minutes cooking at 250°C was concluded and considered to be ideal for the production of better quality tandoori chicken.

Key words: *Tumbling, Tandoori chicken, Microbial quality, Chemical property.*

INTRODUCTION

Since the world is witnessing the rising demand of fast foods, the need of simple and low cost further-processed meat products like chicken tandoori with improved nutritive values will boost the further processing of chicken meat. Various commercial marinade solutions are available in market, containing a complex solution of water, salts, polyphosphate, flavorings and other ingredients, which can be applied to the meat by the techniques of soaking, blending, tumbling or injection. Marination is a popular technique used to accelerate marinade transport throughout the meat, tenderize and improve the quality characteristics of meat products[22].

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The marination coupled with tumbling under vacuum is a unique means of tenderization by loosening the muscle structures, disrupting muscle cells and destroying the connection between the myofibers and the connective tissue. Tumbling can be defined as the massaging of meat surfaces and this process involves a transfer of kinetic energy and consequently causes alteration in muscle tissue. Tumbling results in the formation of protein exudate which acts as a sealer when the protein is denatured during thermal processing[23]. This sealer helps to hold in juices during smoking and cooking, and results in increased yields, increased juiciness and improved slicing characteristics of the finished product. Tumbling also improves the tenderness and causes more uniform cured meat color.

Tandoori Chicken is an Indian dish made by baking large pieces of chicken which have been marinated in spices and yogurt. It is traditionally made on skewers in a tandoor (Indian clay oven). Skinless meat is marinated in a tumbler (massager), operated in a static, vacuum or high pressure to improve marinade absorption and uniformity[24]. Operating under vacuum helps in removing the air bubbles from the exudates and might also assists in protein extraction[3]. cooking temperature has effect with improvement in functional properties of meat and reducing microbial population in product[12]. Microbiological analysis provided useful information to meat processors regarding the sanitary conditions, microbial spoilage problems and an estimate of expected storage life of meat[8] .Total plate count would give as much information as any other suggested microbial index for assessing processed and storage of food products[n n15] m. Meat spoilage did not occur until the total bacterial count reaches level of 10 [6-8] g^{-1} or cm^{-2} [11] . The objective of this work was, therefore, to determine which time period was most suitable to prepare tandoori chicken. Keeping this in view, this research trial were carried out and investigated related to various tumbling time periods under vacuum for their effects on the chemical and microbial properties, sensory quality and economy of tandoori chicken production.

MATERIAL AND METHODS

Experimental design

For the present study, breast meat obtained from commercial broiler chicken of same hatch and age of 6 weeks, was used. The breast, cut into two equal halves longitudinally, was subjected to marination at different vacuum tumbling time exposures as follows.

i) T_0 (Control group): No tumbling
ii) T_1: 30 minutes tumbling
iii) T_2: 1 hour tumbling
iv) T_3: 2 hour tumbling
v) T_4 : 3 hour tumbling

For each treatment, breast from a single bird was used. The composition of the marinade solution was optimized in preliminary investigations and designed as given in Table 1 (g/kg meat). The breast cuts were weighed and placed in a vacuum tumbler (ESK-125, Kakona Gmbh Company, Kempten, Germany) together with the corresponding volume of marinade for tumbling marination treatments, whereas in T_0 group, breast pieces were left in marinade solution for three hours. After marination, the samples were immediately patted with tissue paper to absorb surface water and were hung in the earthen tandoori oven with the use of skews and cooked for 10 - 20 minutes at 250°C to prepare tandoori chicken breast. The whole design was replicated twelve times. Fresh meat as well as tandoori prepared thereof were subjected to chemical and microbialanalysis as detailed below.

pH: The pH measurement was done by digital pH meter (Cyber scan pH 510, Merck). About 5 g of sample was homogenized with 45 ml of distilled water in a laboratory blender for about one minute. The pH was recorded by immersing the combined glass electrodes of digital pH meter in the homogenate. The pH meter was calibrated with standard buffer solutions of pH 4 and 10 as per the user manual instructions, prior to measurement.

Table 1: Ingredients of Marinade solution[20]

Ingredients	Quantity (g/Kg of dressed chicken)*
Anise	5
Black pepper	5
Caraway	3
Cardamom	3
Clove	2
Cumin	5
Red chili powder	10
Turmeric powder	5
Salt	35
Kachri	1
Peeled Onion	50
Peeled garlic	20
Curd	500
Lemon	Juice from two lemon fruits (10 ml)
Cinnamon	2
Peeled ginger	20

*Excluding of giblets

Tyrosine value: Tyrosine value was determined by the modified method of Strange *et al.*[25]. The extract of 20 g sample, prepared in 50 ml of cold 20% TCA by blending for 2 minutes, was used for the estimation of tyrosine value. With reference to the standard graph, the tyrosine value was calculated as mg of tyrosine / 100 g of tandoori chicken sample.

Thio-Barbituric acid (TBA) value: The oxidation of muscle and product is of primary concern among food technologists as it is considered as a major cause of deterioration in the quality of muscle foods. MDA (Malonaldehyde), a secondary product from lipid oxidation, is commonly used as an oxidation index in muscle foods, and different analytical techniques have been reported to determine and quantify it. TBA value was estimated as per the Strange *et al.*[25]. The extract of 20 g sample, prepared in 50 ml of cold 20% TCA by blending for 2 minutes, was used for the estimation of TBA value. The O.D value was taken at 532 nm with the Spectrophotometer (UV- VIS Spectrophotometer, ELICO, SL 164 double beam) and TBA number was calculated as mg malonaldehyde (MDA) per Kg of the sample by multiplying O.D value with K-factor of 5.2.

Total Viable Count (TVC): The microbial load of the samples were estimated as Total Viable Count, following the method described by Swanson *et al.*[26] for sampling and making tenfold serial dilution, plating in plate count agar followed by incubation and counting. About 5 g sample was homogenized with 0.1% peptone water (Himedia) with the aid of sterile pestle and mortar under aseptic condition to give a 10^{-1} initial dilution. The homogenate was used for the preparation of serial dilutions up to 10^{-6} with 0.1% peptone water in sterile test tubes. One ml aliquot of each dilution was placed in identified sterile petridishes aseptically. About 12-15 ml of sterile molten and cooled (45°C) plate count agar (Himedia) was poured on each petridish and mixed gently. After setting, the plates were incubated at 37°C for 48 hours and colonies were counted using a Quebec colony counter, which had 25 to 250 colonies per plate. The count was multiplied by the respective dilution and calculated per gram of sample in log values.

Yeast and Mould count: Sabouraud's dextrose agar was used for isolation and enumeration of yeast and mould count. The plates were incubated at 30°C for 48 hours.

Colonies were counted and expressed as log CFU/g of sample.

Statistical analysis: All the data were analyzed by one-way analysis of variance using general linear model (GLM) procedure of the SPSS software-20. The Duncan's New Multiple Range Test was used to detect significant differences between individual means of respective treatments with significance level set at ($p<0.05$).

RESULT AND DISCUSSION

Chemical properties

The results pertaining to chemical properties (pH, TBA value and Tyrosine value) of fresh meat and tandoori product has been presented in Table 2.

Table 2: Chemical properties of fresh meat and the tandoori product produced thereof

Treatment groups	Parameters					
	pH		TBA value		Tyrosine value	
	Fresh meat	Product	Fresh meat	Product	Fresh meat	Product
T_0	5.69 ± 0.08	5.62 ± 0.06	0.17 ±0.02	0.26^{ab} ± 0.02	1.29 ± 0.07	23.18 ± 2.95
T_1	5.65 ± 0.04	5.70 ± 0.06	0.14 ±0.01	0.24^{a} ± 0.01	1.35 ± 0.05	23.01 ± 2.96
T_2	5.53 ± 0.04	5.71 ± 0.03	0.15 ±0.02	0.27^{ab} ± 0.01	1.34 ± 0.06	23.76 ± 2.58
T_3	5.51 ± 0.05	5.76 ± 0.05	0.14 ±0.01	0.31^{bc} ± 0.02	1.35 ± 0.06	23.19 ± 2.95
T_4	5.73 ± 0.19	5.86 ± 0.04	0.14 ±0.01	0.35^{c} ± 0.02	1.41 ± 0.06	23.69 ± 2.53
F Value	0.00NS	1.52^{*}	1.39NS	4.74*	0.75^{NS}	0.33^{NS}

Column bearing different superscripts (ABC) differ significantly and rows bearing different superscripts (ab) differ significantly. NS-Not significant (P>0.05)

pH: There was no significant difference in pH of fresh meat samples before the application of treatments. However, significant (P<0.05) rise in pH of tandoori product produced thereof was observed. The significant differences were also observed between the treatments in the tandoori product. The significantly highest pH value was observed in treatment T_3 (2 hours tumbling) and lowest in T_0 (Control-No tumbling), whereas, T_1, T_2 & T_4 yielded intermediate values. It can be observed from the results that cooking of meat to tandoori has resulted in significant rise of pH and among the tandoori products tumbling has significantly increased the pH of the product.

It has been reported that cooked meat has a slightly higher pH than the raw meat because during cooking, the acidic groups of the meat proteins are expelled with the juices and the remaining meat proteins become more alkaline[16]. Higher degree of free acidic group from the meat protein subjected to heat can be a reason for rise in pH of cooked meat than raw meat[17]. Increase in pH can also be ascribed to increase in free imidazolium groups of histamine in the myofibrillar proteins. The increase of pH as a result of tumbling may be due to the increased penetration of curing solution into the meat samples[9].

Thio-Barbituric Acid (TBA) value: There were no significant differences in TBA values of fresh meat samples prior to the application of treatments. However, significantly (P<0.05) higher TBA values of tandoori product produced thereof were observed. However, significant (P<0.05) higher differences were observed between the treatments in the TBA values of tandoori product. These observations clearly revealed that high temperature cooking increased the TBA value of the meat product produced and effect of tumbling was observed.

TBA was used as an indicator of food quality and was highly correlated with rancidity and warmed over flavour in muscle foods. Younathan and Watts stated that heating doublnes the amount of free fatty acids in meat which might be due to irreversible conversion of iron in the porphyrin ring of myoglobin pigments to the ferric form during heating. It is only ferric form of iron which catalyzes the lipid oxidation, not the iron bound to transferrin or ferritin or the central iron component in

heme pigments[2]. In the present study, cooking might have enhanced phospholipids oxidation, thus causing TBA values to rise[13]. Storage time increases TBARS values followed a significant ($p<0.05$) linear increasing trend[21].

Tyrosine Value: The Tyrosine values determined from fresh meat samples revealed no significant differences before subjecting them to various treatments. However, the tandoori product produced thereof has shown significantly ($P<0.05$) higher tyrosine values as compared to fresh meat samples. No significant differences were observed in the tyrosine values of the product from different treatments. From these results, it can be stated that high temperature cooking increased the increase of Tyrosine value of the meat product produced with no effect of tumbling. Increase in the concentration of tyrosine, ammonia and NPN compounds occur due to microbial proteolytic activity, which occurs only when spoilage is in a very advanced stage because bacteria usually produced proteolytic enzyme in the late phase of growth[5]. However, in the present study, this cannot be the reason as the cooking was done at a very high temperature. Thus, the thermal processing at high temperature might have caused an increase in the rate of protein break down resulting more free amino acids which in turn lead to higher Tyrosine values in the product[6].

Microbial properties

The results pertaining to microbial properties of fresh meat and tandoori product has been presented in Table 3.

Table 3: Microbial properties of fresh meat and the tandoori product produced thereof

Parameters	Total Plate Count (TPC)		Yeast Mould Count (YMC)	
	Fresh meat	Product	Fresh meat	Product
T0	4.30 ± 0.018	3.49 ± 0.01	4.44 ± 0.01	3.45 ± 0.01
T1	4.31 ± 0.013	3.50 ± 0.01	4.47 ± 0.01	3.46 ± 0.01
T2	4.29 ± 0.016	3.48 ± 0.01	4.46 ± 0.01	3.47 ± 0.01
T3	4.31 ± 0.012	3.48 ± 0.01	4.46 ± 0.01	3.45 ± 0.01
T4	4.32 ± 0.014	3.49 ± 0.01	4.45 ± 0.01	3.46 ± 0.01
F Value	0.37^{NS}	0.98^{NS}	1.46^{NS}	1.46^{NS}

Rows bearing different superscripts (ab) differ significantly. NS-Not significant ($P>0.05$)

Total Plate Count (TPC): The Total Plate Count (TPC) of fresh meat samples revealed no significant differences before the application of various treatments. However, the tandoori product produced thereof has shown significantly ($P<0.05$) lower TPC as compared to fresh meat samples. No significant differences were observed in the TPC of the product as a result of different treatments. It was observed that due to high temperature cooking, the decline of microbial count in tandoori product occurred without any effect on tumbling. It was reported that internal temperature of 80°C attained during preparation of tandoori chicken is sufficient to destroy *Coliforms* and *S. aureus* like organisms[19]. However, in contrast, Ghavimi *et al.*[10] reported that tumbling would enhance water and acid transport between meat and solution; and marinade penetration and diffusion were therefore accelerated, thus decreasing the microbial count.

Yeast and Mould Count: The yeast and mould count of fresh meat before application of different treatments and that of tandoori product revealed no significant difference between different treatments. Similar to the present study, Bharti *et al.*[4] reported no significant effect of tumbling time on the yeast and mould count of chicken tikka.

CONCLUSION

The current study concludes that high temperature cooking has significantly increased pH, TBA value and Tyrosine value, whereas, significantly highest pH in tandoori

is observed as a result of 2 hours of vacuum tumbling. No effect of vacuum tumbling is observed on microbial quality whereas high temperature cooking significantly reduces microbial load in the tandoori chicken.

REFERENCES

1. Acton, J. C. Effect of heat processing on extractability of salt soluble proteins, tissue binding strength and cooking losses of poultry loves. *Journal of Food Science.*, **37:** 244-46 (1972).
2. Ahn, D. U., Wolfe, F. H and Sims, J. C. The effect of free and bound iron on lipid peroxidation in turkey meat. *Poultry Science*, **72:** 209-215 (1993).
3. Barbut, S. Poultry products processing. First Indian reprint, 2005. CRC press, London, Noida, 315-427 (2005).
4. Bharti, S. K., Tanwar, V. K., Anita and Palod, J. Effect of vacuum packaging on microbiological quality of roasted chicken. *Indian Journal of Veterinary Research*, **19(2):** 55-59 (2010).
5. Dainity, R. H., Shaw, B. G., DeBoer, K. A and Scheps, E. S. J. Protein changes caused by bacterial growth on beef. *Journal of Applied Bacteriology*, **39:** 73-81 (1975).
6. Devadason, P., Anjaneyulu, A. S. R., Mendirtta, S. K and Murthy, T. R. K. Quality and shelf life of buffalo meat blocks processed in retort pouches. *Journal of Food Science and Technology*, **51(12):** 3991-3997 (2014).
7. Dzudie, T and Okubanjo, A. Effect of rigor state and tumbling time on quality of goat hams. *Journal of Food Engineering*, **42:** 103-107 (1999).
8. Forrest, C. J., Aberle, E. D., Hedrick, H. B., Judge, M. D and Merkel, R. A. Structure and Composition of muscle and associated tissues. Principles of Meat Science., N. H. Freeman and Co., San Francisco, 25-81 (1975).
9. Froning, G. W and Sackett, B. Effect of salt and phosphates during tumbling of turkey breast muscle on meat characteristics. *Poultry Science*, **64:** 1328-1333 (1985).
10. Ghavimi, B., Roigers, R. W., Althan, T. G and Ammerman, G. R. Effects of non-vacuum, vacuum and nitrogen back flush tumbling on various characteristics of restructured cured beef. *Journal of Food Science*, **51:** 1166- 1168 (1986).
11. Gill, C. O., Meat spoilage and evaluation of the potential storage life of fresh meat. *Journal of Food Protection*, **46(5):** 444-452 (1983).
12. Giri, A. K and Biswas, A.K. Effect of different cooking methods on the physic-chemical and sensory quality of spent broilers breast fillets. storage. *Indian Journal of Poultry Science*. **51(2):** 207-212 (2016).
13. Gokalp, H. Y., Ockerman, H. W., Plimpton, R. F and Harper, W. J. Fatty Acids of Neutral and Phospholipids, Rancidity Scores and TBA Values as Influenced by Packaging and Storage. *Journal of Food Science*, **48:** 829-834 (1983).
14. Harmon, C. J., Means, W. J., Kemp, J. D. Blind sensory and chemical properties of restructured dry cured hams. *Journal of Food Science*, **48:** 1039-1040 (1992).
15. Ingram, M. Microbiological standards for food. *Food Technology.*, **15:** 4-16 (1961).
16. Law, H. M., Yang, S. P., Mullins, A. M and Fielder, M. M. The effect of storage and cooking on qualities of loin and top round steaks. *Journal of Food Science*, **32:** 637-641 (1967).
17. Lawrie, R. A. Meat Science, 6th edn. Chapter-10, pp 232-267, Chapter 6, pp132-135Pargamon Press, Oxford (1998).
18. Muller, W. B., Effect of method of manufacture. Fleischwirtschaft, **71(8):** 10-18 (1991).
19. Nair, K. K. S., Rao, D. N., Nagin, C., Nair, R. B., Puttarajappa, P and Amla, B. L..Tandoori chicken processing optimized by response surface methodology. *Journal of Food Quality*, **18:** 103-117 (1995).
20. NarasimhaRao., Assessment of physical, chemical and microbial attributes in

traditional Indian Poultry Products Tandoori and Kabab. In proceedings of the *XX World's Poultry Congress*. New Delhi, India. **111:** 57-64 (1996).

21. Para, P. A., Kumar, S., Raja, W. H and Ganguly, S. Effect of clove oil on some quality characteristics and sensory attributes of papaya pulp enriched enrobed chicken nuggets at refrigerated storage. *Indian Journal of Poultry Science*. **52 (1):** 96-103 (2017).
22. Pietrasik, Z and Shand, P. J. Effect of mechanical treatments and moisture enhancement on the processing characteristics and tenderness of beef semi-membranous roast. *Meat Science*, **71(3):** 498- 505 (2005).
23. Rust, R. E and Olson, D. GMeat curing principles and modern practice. Koch supplies, Inc., Kanas city, Missouri (1973).
24. Sams, A. R. Poultry meat processing edition, Boca Raton, CRC Press, Taylor and Francis group, Florida, USA (2001).
25. Strange, E. D., Benedict, R. C and Smith, J. C., Evaluation of rapid test for monitoring adulteration in meat quality during storage. *Journal of Food Protection.* **40:** 843-847 (1977).
26. Swanson, K. M. J., Busta, F. F., Peterson, E. H and Johnson, M. G., *Colony count methods*. In Compendium of Methods for the Microbiological Examination of Foods, 3rd edn.Vanderzant Cand Splittstoesser D F. American Public Health Association, Washington, DC, 75-95 (1992).
27. Theno, D. M., Siegel, D. G. and Schmidt, G. R., Meat massaging: Effect of salt and phosphate on the ultra-structure of cured porcine muscle. *Journal of Food Science,* **43:** 488-492 (1978).
28. Wilson, B. R., Pearson, A. M and Shorland, F. B., Effect of total lipids and phospholipids on warmed over flavour from several species as measured by Thiobarbituric acid analysis. *Journal of Agriculture and Food Chemistry,* **24(1):** 7-11 (1976).
29. Younathan, M. T and Watt, B. M., Relationship of meat pigment to lipid oxidation. *Food Research*, **85:**657-663 (1959).