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Assessment of the stability of processed broiler chicken under storage

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Abstract

Meat is very nutritious and as such can easily be contaminated with microorganisms especially when stored under conditions where temperature cannot be controlled. This study was conducted to assess the storage stability of the processed meat type chicken. Differently processed chicken samples were carefully packaged in sterile high density polythene bags. The samples were stored at room temperature (25± 2°C), fridge temperature (4°C), and freezer temperature (-18°C) for 28 days. In each case, a detailed microbial analysis was carried out on the samples. The three treatment samples and the control were packaged separately according to the number of period they would be analyzed. Each of the treatment samples were withdrawn and analyzed for microbiological quality. Samples were taken at 7 days interval, namely, day 1, day 7, day 14, day 21, and day 28. The effect of storage period on microbiological status was also determined. The microbial isolates of meat stored under room temperature increased with increased storage period from day 14 through day 21 to day 28 (Day 14 = 71, Day 21 =81 and Day 28 =86 for smoked chicken; Day 14 = 72, Day 21 =81 and Day 28 =89 for oven dried chicken; Day 14 = 65, Day 21 = 77 and Day 28 =86 for fried chicken). While the isolates of meat stored under condition decreased with storage period from day 14 through day 21 to day 28 (Day 14 = 49, Day 21 = 42 and Day 28 = 21 for smoked chicken; Day 14 = 44, Day 21 = 35 and Day 28 = 20 for oven dried chicken; Day 14 = 44, Day 21 = 39 and Day 28 =27 for fried chicken). The meat stored under freezing condition did not only decrease from day 14 through day 21 to day 28, it also had the least number of isolates at day 28 of storage (Day 14 = 36, Day 21 = 25 and Day 28 = 20 for smoked chicken; Day 14 = 40, Day 21 = 25 and Day 28 = 20 for oven dried chicken; Day 14 = 46, Day 21 = 31 and Day 28 =17 for fried chicken).

Keywords: Chicken, storage, stability, processed meat, refrigerator, freezer

Evaluation de la stabilité de poulet transformé au stockage

Résumé

La viande est très nutritive et, en tant que telle, peut facilement être contaminée par des micro-organismes, en particulier lorsqu'elle est stockée dans des conditions où la température ne peut pas être contrôlée. Cette étude a été menée pour évaluer la stabilité au stockage du poulet de type viande transformée. Des échantillons de poulet traités différemment ont été soigneusement emballés dans des sacs stériles en polyéthylène haute densité. Les échantillons ont été conservés à température ambiante (25±2oC), au réfrigérateur (4oC) et au congélateur (-18oC) pendant 28 jours. Dans chaque cas, une analyse microbienne détaillée a été réalisée sur les échantillons. Les trois échantillons de traitement et le contrôle ont été emballés séparément selon le nombre de période où ils seraient analysés. Chacun des échantillons de traitement a été prélevé et analysé pour la qualité microbiologique. Des échantillons ont été prélevés à 7 jours d'intervalle, à savoir le jour 1, le jour 7, le jour 14, le jour 21 et le jour 28. L'effet de la période de stockage sur l'état

microbiologique a également été déterminé. Les isolats microbiens de viande conservée à température ambiante ont augmenté avec l'augmentation de la période de stockage du jour 14 au jour 21 jusqu'au jour 28 (jour 14 = 71, jour 21 = 81 et jour 28 = 86 pour le poulet fumé ; jour 14 = 72, jour 21 = 81 et Jour 28 = 89 pour le poulet séché au four ; Jour 14 = 65, Jour 21 = 77 et Jour 28 = 86 pour le poulet frit). Alors que les isolats de viande conservés dans des conditions ont diminué avec la période de stockage du jour 14 au jour 21 jusqu'au jour 28 (jour 14 = 49, jour 21 = 42 et jour 28 = 21 pour le poulet fumé ; jour 14 = 44, jour 21 = 35 et Jour 28 = 20 pour le poulet séché au four; Jour 14 = 44, Jour 21 = 39 et Jour 28 = 27 pour le poulet frit). La viande stockée dans des conditions de congélation n'a pas seulement diminué du jour 14 au jour 21 jusqu'au jour 28, elle avait également le moins d'isolats au jour 28 de stockage (jour 14 = 36, jour 21 = 25 et jour 28 = 20 pour poulet ; Jour 14 = 40, Jour 21 = 25 et Jour 28 = 20 pour le poulet séché au four ; Jour 14 = 46, Jour 21 = 31 et Jour 28 = 17 pour le poulet frit).

Mots clés : Poulet, stockage, stabilité, viande transformée, réfrigérateur, congélateur

Introduction

Meat products are good nutrient media for the growth of microorganisms, which are potential sources of food born infections (Kinsella *et al.*, 2008). This is why Food and Drug Administration, (FDA), recommends that both raw and cooked meat should not be left at room temperature for more than two hours. If that happens bacteria such as *Staphylococcus, Streptococcus, Micrococcus*, *Enterobacter*, *Escherichia*, *Klebsiella*, *Lactobacillus*, *Pseudomonas*, *Shigella, Salmonella, Proteus*, and *Helicobacter pylori* do not only grow in the meat but also multiply at a very dangerous level.In order to solve this identified problem in storage of meat products in room temperature, researchers like Mushin and Hussein (2014) in their study have showed that the occurrence of pathogenic organisms in the meat products can be reduced by the inclusion of garlic in the diet of chicken. This is because garlic extract inhibits the growth of Gram positive and Gram negative bacteria, such as *Staphylococcus, Streptococcus, Micrococcus*, *Enterobacter*, *Escherichia*, *Klebsiella*, *Lactobacillus*, *Pseudomonas*, *Shigella, Salmonella, Proteus*, and *Helicobacter pylori* (Tsao and Yin, 2001). Its antibacterial activity is mainly due to the presence of allicin produced by the enzymatic activity of allinase on alliin.Therefore, using Garlic in processing broiler meat can inhibit bacteria and fungi. Onu (2010) for instance, found that ginger and garlic supplementation at 0.25 percent level in broilers finisher diets enhanced the growth rate of poultry. This may be due to the fact that these additives can inhibit the growth of harmful bacteria including E. coli in the intestinal tract due to the anti-microbial activity. Previous knowledge showed effectiveness of garlic in food storage stability. However, there is limited information on storage at 2% or when combined with other spices; hence the need for the study which is aimed at the assessment of the storage stability of processed broiler chicken under storage using ginger and garlic at 2% level.

Materials and methods

Storage stability study

The experiment was conducted at the Poultry Unit of the Teaching and Research Farm and Meat Science Unit of the Department of Animal Science, Ambrose Alli University Ekpoma, Edo State. A total of 180 day old each Abor Acre broiler chicks sourced from a reputable hatchery in Ibadan, Oyo State Nigeria were used for the experiment. The birds were fed commercial starter mash during brooding phase and then fed with diets supplemented with 2% ginger

rhizome powder and garlic bulb powder, which were purchased from Kaduna, Kaduna State. The chopped dry ginger rhizomes and garlic bulbs were sun dried for 21 days, and later milled using milling machine with particle of 0.15mm sieve powder size. The ginger and garlic powder were stored in air tight clean and dry plastic containers until used. The experiment was a Completely Randomized Design (CRD) replicated three times. The ginger rhizome and garlic bulb powder were included in the birds' meal at 2%, while mixture of ginger rhizome powder and garlic bulb powder were used at 1.1% in the experiment. At the end of the experiment, four birds were randomly selected per replicate and slaughtered. The meat obtained was cured and processed using the additives by frying, oven drying and smoking. The meat samples were packaged in high density polythene bags and stored at room temperature (25±2 ^{0}C), fridge temperature (4^{o}C), and freezer temperature (18^{o}C) for storage studies for five weeks (1st day, 7th day, 14th day, 21st day and 28th day). The microbiological analysis was done using the procedures recommended by International Commission on Microbiological Specifications on Food ((ICMSF, 1986) while the enumeration of the organisms based on storage period was done and recorded as described by Garbur (1997). The storage stability arrangement is shown below (Table 1).

Table 1: Storage stability of different processed chicken meat type

Days of Storage	T_1 G/G(%)	T_2 G%(2%)	T_3 GBP (2%)	T_4 MGGP (1:1%)
1	1day	1day	1day	1day
7	7days	7day	7days	7days
14	14days	14day	14days	14days
21	21days	21day	21days	21days
28	28days	28day	28days	28days

The table shows different days samples were taken for microbial analysis.
S = Smoked Meat**, O**= Oven Dried Meat**, F**= Fried Meat

Results

Microbial isolates from processed meat stored under room temperature, refrigerator and freezer

The effect of storage methods and periods of storage on microbial load of cockerel and broiler meat processed by frying, oven dried and smoking are shown in Tables 2, 3 and 4 under the three different storage methods (Room temperature, refrigerator and freezing) examined in this study. Twelve microbial isolates comprising seven bacteria and five fungi were isolated from the meat of cockerel and broiler smoked, oven dried and fried. The bacterial isolates were identified as *Lactobacillics* spp, *Staphylococcus aureus, Escherichia coli, Pseudomonas fluorescens, Listeria* spp, *Proteus vulgaris* and *Salmonella gallanarum* while the fungi isolates were identified as *Fusanum oxysporum, Aspergillus niger, Aspergillus nidulans, Fusanum solani* and*Penicillin notatum*. *The Penicillin notatum* was absent in all the meat stored in refrigerator while *Aspergillus niger* was absent in all the meat stored in the freezer (Tables 3 and 4). The total microbial counts varied with different processing methods (smoking, frying and oven drying) and storage methods. On the average, fried meat had the least number of microbes across the three storage methods and throughout the storage periods while the meat stored in freezers had the least number of microbes throughout the storage periods. The meat stored under room temperature (Table 2) had the microbial counts increased from 71, 72 and 65 at day 1 to 86, 89 and 86 at day 28 (for smoked, oven dried and fried meat, respectively) with *Escherichia coli* as

Table 2: Microbial isolates from processed meat from (smoked, oven–dried and fried) stored under room temperature

Pathogen	Micro organisms	Storage days														
		Day1			Day7			Day14			Day21			Day28		
		S	O	F	S	O	F	S	O	F	S	O	F	S	O	F
Bacteria	*Lactobactelus spp*	2	2	1	3	4	5	8	8	6	8	8	7	8	8	8
Bacteria	*Escherichia coli*	6	4	5	7	6	6	7	6	6	8	7	7	8	7	8
Bacteria	*Pseudomonas fluorescens*	2	2	5	7	4	7	7	4	6	7	7	7	8	8	7
Bacteria	*Staphylocococcus aureus*	2	4	4	4	6	3	3	6	5	4	5	5	3	6	4
Bacteria	*Proteus Vulgaris*	4	2	2	7	4	6	7	6	6	8	7	7	8	7	7
Bacteria	*Salmonella gallinarum*	1	3	3	4	4	8	4	3	8	6	7	8	7	7	8
Bacteria	*Listeria spp*	0	4	1	3	3	1	5	6	2	8	6	6	8	8	8
Fungi	*Fusarium oxysporum*	8	6	4	8	6	3	8	6	3	8	6	4	8	6	6
Fungi	*Penicillium notatum*	4	5	4	4	6	7	4	7	7	5	8	8	7	8	8
Fungi	*Aspergillus nidulans*	1	2	3	7	7	7	7	7	7	8	7	8	8	8	8
Fungi	*Fusanum solani*	2	1	2	5	4	3	6	6	3	6	7	3	7	8	6
Fungi	*Aspegillus niger*	4	2	3	5	6	6	5	7	6	5	6	7	6	8	8
No of organisms		71	72	65	64	60	62	71	72	65	81	81	77	86	89	86

S = Smoked Meat, **O**= Oven Dried Meat, **F**= Fried Meat

Table 3: Microbial isolates from processed meat from (smoked, oven–dried and fried) stored under refrigerator

Pathogen	Micro organisms	Storage days														
		Day1			Day7			Day14			Day21			Day28		
		S	O	F	S	O	F	S	O	F	S	O	F	S	O	F
Bacteria	*Staphylococcus aureus*	6	6	5	6	6	5	6	3	5	5	2	4	3	1	2
Bacteria	*Escherichia coli*	2	3	4	3	5	8	3	4	6	3	4	6	1	2	4
Bacteria	*Pseudomonas flluorescens*	3	3	1	6	5	0	6	4	0	4	4	0	1	1	0
Bacteria	*Listeria spp*	5	4	3	7	7	7	8	8	7	8	8	7	7	5	7
Bacteria	*Proteus vulgaris*	2	4	4	4	6	4	3	3	4	3	0	4	1	1	3
Bacteria	*Salmonella gallinarum*	5	4	3	6	6	4	6	5	3	4	4	3	0	10	37
Bacteria	*lactobacillus*	3	3	1	5	3	4	3	2	3	3	2	2	0	0	0
Fungi	*Fusarum oxysporum*	2	4	7	2	5	7	3	2	4	1	1	3	0	2	3
Fungi	*Aspergillus niger*	6	3	3	8	7	7	6	6	4	3	4	2	2	2	1
Fungi	*Aspergillus nidulans*	3	4	2	4	7	2	0	3	1		2	0	0	0	1
Fungi	*Fusarum solani*	3	3	5	8	7	8	5	4	7	8	4	8	6	4	5
No of organisms		40	41	38	59	64	56	49	44	44	42	35	39	21	20	27

S = Smoked Meat, **O**= Oven Dried Meat, **F**= Fried Meat

Table 4: Microbial Isolates from Processed meat from (Smoked, Oven–dried and Fried) Stored under Freezing Condition

Pathogens	Micro organisms	Storage days														
		Day1			Day7			Day14			Day21			Day28		
		S	O	F	S	O	F	S	O	F	S	O	F	S	O	F
Bacteria	*Lactobacillus spp*	*5*	*5*	*4*	*5*	*5*	*5*	*1*	*4*	*4*	*1*	*0*	*2*	*0*	*4*	*4*
Bacteria	*Escherichia coli*	*3*	*5*	*1*	*4*	*5*	*3*	*1*	*5*	*2*	*0*	*1*	*0*	*0*	*0*	*0*
Bacteria	*Pseudomonas fluorescens*	*3*	*1*	*4*	*4*	*3*	*6*	*3*	*1*	*3*	*2*	*0*	*2*	*0*	*0*	*0*
Bacteria	*Staphylococcus aureus*	*4*	*3*	*2*	*7*	*5*	*5*	*3*	*4*	*5*	*3*	*6*	*2*	*3*	*2*	*0*
Bacteria	*Proteus vulgaris*	*2*	*4*	*2*	*3*	*2*	*5*	*2*	*2*	*5*	*2*	*1*	*2*	*1*	*0*	*0*
Bacteria	*Salmonella gallanarum*	*4*	*1*	*2*	*4*	*5*	*4*	*0*	*5*	*1*	*0*	*3*	*1*	*0*	*0*	*0*
Bacteria	*Listeria spp*	*4*	*4*	*3*	*8*	*7*	*7*	*8*	*6*	*8*	*4*	*5*	*7*	*5*	*5*	*4*
Fungi	*Penicillum notatum*	*7*	*6*	*7*	*7*	*6*	*8*	*7*	*6*	*8*	*7*	*6*	*8*	*8*	*6*	*8*
Fungi	*Fusarium solari*	*4*	*3*	*3*	*6*	*4*	*4*	*5*	*2*	*2*	*3*	*0*	*1*	*1*	*1*	*0*
Fungi	*Aspergillus nidullans*	*0*	*2*	*5*	*4*	*6*	*5*	*3*	*3*	*4*	*2*	*3*	*3*	*0*	*2*	*1*
Fungi	*Fusarumoxysporum*	*5*	*1*	*4*	*5*	*3*	*5*	*3*	*2*	*4*	*1*	*0*	*3*	*2*	*0*	*0*
No of organisms		*41*	*35*	*37*	*57*	*51*	*57*	*36*	*40*	*46*	*25*	*25*	*31*	*20*	*20*	*17*

S = Smoked Meat**, O**= Oven Dried Meat**, F**= Fried Meat

the most prevalent bacterium and *Penicillin notatum* as the most prevalent fungus. At day 28, all the microbial isolates identified in this study were present in all the meat stored under room temperature. Conversely, the microbial counts observed on the meat stored in refrigerator and freezers decreased considerably from 40, 41 and 38 at Day 1 to 21, 20 and 27 at Day28 for the meat stored in refrigerators and 41, 35 and 37 at Day 1 to 20, 20 and 17 at Day 28 for the meat stored in freezer. At Day 28, fried meat stored in freezer had the least microbial loads (17) including *Lactobacillics* spp, *Listeria* spp*,* *Penicillin notatum* and *Aspergillus niger,* with *Penicillin notatum* as the most prevalent microbes (47%).

Discussion

Effect of different methods and periods of storage on processed meat type stored under room temperature, refrigeration and freezer

The results of the effects of different methods and periods of storage of processed meat of cockerel and broiler in the current study confirmed that processed meat are highly susceptible to spoilage and food poisoning organisms but varied in degree of susceptibility with respect to storage condition and time. This agreed with the statement made by Datta *et al.* (2012) that processed meat foods are more prone to contamination with pathogenic microorganisms during the various stages of processing. The presence of diverse species of microbes at high frequencies on the meat at Day 1 suggested that the meat samples could have been contaminated from the environment. This is because Meat are rich in nutrients required for growth and proliferation of microorganisms. Microbes such as *Proteus* and *Pseudomonas spp* are common environmental contaminants of food and food products. Species of *Klebsiella, Enterobacter, and Escherichia coli* are members of Enterobacteriaceae associated with the gastrointestinal tract and according to Famurewa *et al.* (2017), their *presence* in the meat samples may be attributed to poor sanitary practices in slaughtering, processing, and packaging prior to storage (Famurewa *et al.,* 2017).In the current study, the population of the microbes found on the meat stored under room temperature increased as the storage period increased from Day 1 to Day 28. This was expected because the storage temperature was not controlled and most microbes proliferate under room temperature. In addition, increase in number of microbes from Day 1 to Day 28 could also be attributed to the presence of moisture in the meat and oxygen at the surface of the meat stored under room temperature. This is just as Gandotra (2015) had reported that gradual increase in microbial counts of meat with storage could be attributed to high moisture and nutrient contents of the samples which could promote the growth of the organisms (Gandotra, 2016). Similarly according to Hall (1997) and Farber (2000), food-borne illnesses associated with *E.coli*, *Staphylococcus aureus, Salmonella sp.* and *Listeria monocytogenes,* are major health concern. Thus, the presence of these organisms in higher frequencies showed that the meat samples stored under room temperature may not be hygienic for human consumption. Conversely, the microbial load counts of the meat stored under refrigerator decreased as the storage period increased from Day 1 to Day 28. The initial high microbial counts at Day 1 may be attributed to preparation, handling and distribution of meat to refrigerator for storage. Refrigeration is the most widely used method of preservation especially for short term storage of meat as it slows or limit the spoilage rate at temperature below the optimal range and can inhibit the microbial growth (Cassens, 1994), enzymatic as well as chemical reactions

(Cassens, 1994; Pal, 2014). The optimum storage temperature is 2^0 C. However, organisms such as, *E. coli, Salmonella gallanarum, Staphylococcus aureus* and certain strains of *Salmonella* are psychrophilic organisms and thus showed highest level of prevalence at Day 28 of refrigerator storage. This suggested that they resisted refrigerator temperature and thus can survive under low temperature of the refrigerator. According to Pal (2014), refrigerated temperature favors the growth of psychrophilic organisms causing spoilage of meat in due course of time. Nevertheless, the longer the meat samples stayed in the refrigerator, the lower the microbial loads and thus the safer the meat samples for consumption with the exception of *Salmonella gallinarium* which is psychrophilic in nature.

Conclusion

The study showed that different methods and periods of storage of processed meat of cockerel and broiler chicken in the current study confirmed that processed meat are highly susceptible to spoilage and food poisoning organisms but varied in degree of susceptibility with respect to storage condition and time.

References

Bajpai, M., Pande, A., Tewari, S.K. and Prakash, D. 2005. henolic contents and antioxidant activity of some food and medicinal plants. *International Journal of Food Science and Nutriton.* 56, 4, 287-291.

Cassens, R.G.1994. *Meat Preservation, Preventing Losses and Assuring Safety* 1st Edition. USA: Food and Nutrition Press, Inc. Trumbull, Connecticut 79-9

Datta, S., Akter, A., Shah, I.G., Fatema, K., Islam, T.H., Bandyopadhyay, A., Khan, Z.U.M. and Biswas, D. 2012. Microbiological Quality Assessment of Raw Meat and Meat Products, and Antibiotic Susceptibility of Isolated *Staphylococcus aureus.Agriculture, Food and Analytical Bacteriology. 2 (3): 187 - 193.*

Demir, E., Kiline, K. and Yildirim, Y., 2005.Use of antibiotic growth promoter and two herbal natural feed additives with and without exogenous enzymes in wheat base broiler diets. *South Africa Journal of Animal Science,* 35, 61-72.

Famurewa, J.A.V., Akise, O.G. and Ogunbodede, T. 2017. *Effect of storage methods on the nutritional qualitiies of African Catfish Clarias garepinus, Burchell, 1982. African Journal of Food Science. 11 (17): 223-233.*

Farber, J.M. 2000. The present situation in Canada regarding *Listeria monocytogenes* and ready-to-eat seafood products. *InternationalJournal of Food Microbiology* 62, 247-256.

Food and Drug Administration, (FDA) 2021. *FDA Made Easy.* Retrieved from https//www.registrarcoop.com/fda/assistance

Gandotra, R., Koul, M., Gupta,S. and Gupta, V.2015. Studies on the effect of vacuum packaging on some quality changes in *Labeorohita* during the frozen storage *period. International Journal of Recent Scientific Research 6 (*2): 78-84.

Gandotra, R.; Raj, S., Sharma, M. and Kumari R. 2016. Studies on the effect of vacuum packaging on biochemical and microbial quality of frozen stored muscle of common carp, Cyprinus carpio.

International Journal of Recent Science Research. :13993-13998.

Garbur, J. 1997.*Essential of food microbiology.* London: ARNOLD.

Hall, R.L. 1997. Food-borne illness: implications for the future. *Journal ofEmerging Infectious Disease* 3: 555-559.

ICMSF 1986. Micro-organisms in Food-2. Sampling for Microbiological Analysis: Principles and Specific Applications ICCMSF, Oxford: Blackwell Scientific Publications.

Kinsella, K.J., Prendergast, D.M., McCann, M.S., Blair, I.S., McDowell, D.A. and Sheridan, J. 2008. The survival of *Salmonallea enteric* serovar Typhimurium DT 104 and total viable counts on beef surfaces at different relative humidities and temperatures. *Journal of Applied Microbiology*. 106:171-180.

Muhsin, D.A. and Hussein, F.M. 2014. The Antibacterial Effect of Ginger and Garlic Extracts on Some Pathogenic Bacteria Isolated from Patients with Otitis Media. *International Research Journal of Medical Sciences*, 2, 5, 1-5.

Pal, M. 2014.*Preservation of various foods.* Ph.D. Lecture Note, Addis Ababa University, College of Veterinary Medicine and Agriculture, Debre Zeit, Ethiopia, 1-11.

Tsao, S.M. and Yin, M.C. 2001. *In vitro* antimicrobial activity of four diallylsulphides occurring naturally in garlic and Chinese leek oil. *Journal of Medical Microbiology*, 50, 646-649.

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