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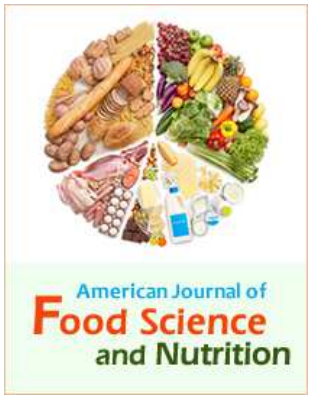

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Effects of local clay pot and freezer preservation methods on beef quality attributes

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Abstract
This study was carried out to investigate the influence of local clay pot and freezer preservation on quality properties of fresh beef. 30 clay pots were moulded. 6kg of beef was purchased from Ayetoro abattoir and divided into two portions of 3kg wrapped in banana leaves and each portion constituted a treatment; T1 = Freezer, T2 = Clay pot. The clay pots were sealed containing 100g of beef each and heated on charcoal fire for 1 hour daily, while beef preserved in freezer was divided into 30 parts of 100g and frozen at -18^{o}C. Physicochemical, microbiological and sensory properties of preserved beef were determined at 0, 7, 14, 21 and 28 days. Data collected were analysed with ANOVA at p = 0.05. Beef in T1 had higher colour score and lower ($p<0.05$) shear force values, while beef in T2 had higher yield and lower thermal shortening, protein, ash and TBA were higher in beef preserved with T2 while moisture and fat were higher in T1 beef. Microbial load were higher in T1 as well as colour, tenderness and texture. However, flavour, odour and acceptability were higher in T2. All properties of preserved beef with the exception of cooking loss, thermal shortening, ash, Thiobarbituric Acid (TBA), Total Coliform Count (TCC) and Total Anaerobic Count (TAC) increased as the time of preservation increased. It is suggested that local clay pot be used by those in developing countries where power supply is still epileptic especially in rural areas, and that beef may not be preserved beyond 14 days since beef properties decreased after that period in this study.

1. Introduction

Meat is a high energy type of food considered to be the food of choice largely due to its nutritional value. It is however has short shelf life due to microbial and oxidative spoilage (Houben *et al.*,2000, Banani *et al.*, 2006). Meat quality is a measure of its palatability and acceptability to consumers and depends on several factors such as pH and microbial load (Apata, 2011). In order to extend meat shelf life there is need to reduce initial microbial load during processing which aids in producing varieties of meat

products as well as preserve the meat (Omojola, 2008). Various modern methods have been used in meat preservation such as irradiation, chilling, freezing and refrigeration among others, but they are not always at the reach of rural dwellers who are sometimes distant from electricity supply in developing countries (George *et al.*, 2009). Therefore, the need to develop and use effective, cheap simple and appropriate preservation technology that is well adapted to the climatic, social and economic conditions of these countries becomes a sine-qua-non (Mohammed 2005). Among these local preservation methods are salting, smoking, drying and frying and use of clay pot. Reports are available on effects of salting, smoking, drying and frying on meat quality (FAO 2007). But there are scanty information on the use of clay pot for meat preservation and its influence on the meat quality characteristics, hence the need to carry out this study to investigate the consequences of clay pot preservation method on meat quality attributes to fill the gap in the literature.

2. Materials and Methods

2.1. Preparation of Test Materials

2.1.1. Clay Pots

30 clay pots were moulded using clay soil which was obtained from the bank of a river near the college of Agricultural Sciences Teaching and Research Farm, Ayetoro. The clay soil was moulded into pots with the aid of dome-shaped plastic bowl until desired shape was attained following the procedures of Mohammed (2005).

2.1.2. Meat (Beef)

6kg of beef was purchased from Ayetoro abattoir and was divided into 2 portions of 3kg. The meat was wrapped in banana leaves and enclosed in the moulded clay pots, except the control treatment that was placed into a freezer at -18^0C thus, the beef in the freezer constituted treatment 1 (T1) and beef enclosed in the moulded clay pots constituted treatment 2 (T2).

2.1.3. Charcoal Heating

Beef enclosed in the clay pots were heated on charcoal fire for 1 hour daily with frequent turning at 20 min interval done to ensure even heating of the beef as described by FAO (1990).

2.1.4. Preservation of Beef

The beef in T1 and T2 were preserved for 28 days during which time data were collected.

2.2. Data Collection

Data collected included Physical properties of beef which included cooking loss, drip loss, thermal shortening, shear force, water holding capacity and beef colour following the procedures of AMSA (1991), Suzuki (1991), Honikel (1998) and Qioafen Da-Wen (2005).

2.3. Chemical Analysis

This included moisture crude protein, ether extract (fat), ash, thiobarbituric acid (TBA) and pH of beef as described by Hansen *et al.* (2004) and AOAC (2000).

2.4. Microbiological Analysis

This analysis was carried out following the procedures of ICMSF (1986), APHA (1992) and AOAC (2000).

2.5. Sensory Evaluation

10-member panel was used to rate the meat samples for colour, flavour, odour tenderness, juiciness, texture and overall acceptability and were analysed based on 9-point hedonic scale on which 1= dislike completely and 9= like completely according to AMSA (1995).

2.6. Experimental Design and Statistical Analysis

Completely randomized design with 2 x 5 factorial arrangement was employed in this study. Data collected were analysed with analysis of variance (ANOVA) using (SAS, 2002). Significant means were separated with Duncan multiple range test of the same software.

3. Results

Table 1. *Physical properties of beef preserved freezer and clay pots*

Variable						
Parameter	**Raw MeatColour**	**Cooking loss (%)**	**Thermal shortening (%)**	**Shear Force (N)**	**WHC (%)**	**Cooking Yield (%)**
Treatment						
T1	6.5^{a}± 0.8	13.80±0.45	10.00^{a}±0.46	2.97^{b}±0.06	60.50^{a}±0.04	8620±0.01
T2	4.20^{b}±0.8	13.00±0.01	8.50^{b}±0.42	4.16^{a}±1.00	58.00^{b}±0.04	87.00±0.03
Time						
0	6.25^{a}±0.52	10.00^{d}±0.44	13.33^{c}±2.29	1.86^{b} 0.41	65.25^{a}±0.36	90.00^{a}±1.44
7	4.85^{b}±1.03	12.00^{c}±8.77	15.00^{b}±9.32	2.15^{b}±0.44	60.15^{b}±1.28	88.00^{b}±8.77
14	4.51^{b}±1.01	15.00^{b}±6.43	15.50^{b}±4.40	2.45^{b}±.62	58.26^{c}±4.68	85.00^{c}±6.42
21	4.38^{b}±0.52	18.45^{a}±8.53	17.00^{a}±1.18	3.76^{a}±0.92	50.10^{d}±4.66	81.55^{d}±0.52
28	3.32^{c}±0.84	18.60^{a}±8.82	17.30^{a}±2.23	3.87^{a}±1.26	47.15^{e}±5.21	81.40^{d}±0.44

a b c d: Means on the same column with different superscripts are statistically significant ($p<0.05$).
WHC= water holding capacity

The results of physical characteristics of beef preserved in freezer and clay pot are presented on Table 1. Treatment 1 (T1) showed higher ($p<0.05$) raw meat colour, water holding capacity (WHC) and thermal shortening values than T2 while shear force was higher ($p<0.05$) difference between T1 and T2 in cooking loss and yield. Raw meat colour, WHC and cooking yield decreased ($P<0.05$) as the time of preservation increased while cooking loss and shear force values increased.

Table 2 shows the results of chemical composition of beef preserved with freezer and clay pot. T1 furnished higher ($p<0.05$) moisture and ether extract (fat) while T2 elicited higher ($p<0.05$) protein and ash values as well as lower ($p<0.05$) fat. There was no significant ($p>0.05$) difference in the pH of the beef in the two treatment thiobarbituric acid (TBA) values was higher ($p<0.05$) in T2. The results revealed further that moisture values decreased ($p<0.05$) unabated till 28^{th} while (TBA) value increased. Crude protein decreased 14^{th} and 21^{st} day and decreased further to 28^{th} day. Fat also decreased up to 7^{th} and 14^{th} day then decreased further to 28^{th} day. Ash content increased to 7^{th} and 14^{th} day the same ($p>0.05$) and further increased ($p<0.05$) to 21^{st} and 28^{th} day the same ($p>0.05$) but no significant ($p>0.05$) difference was observed in the pH of the preserved meat.

Table 2. *Chemical composition of beef preserved with freezer clay pots*

Variable						
Parameter	**MC (%)**	**CP (%)**	**EE (fat) (%)**	**Ash (%)**	**TBA**	**pH**
Treatments						
T1	68.60^{0}±0.11	18.30^{b}±0.05	8.30^{a}±0.05	2.50^{b}±0.08	0.35^{b}±0.02	6.20±0.05
T2	66.80^{b}±0.33	20.70^{a}±0.03	6.20^{b}±0.06	3.80^{a}±0.05	0.37^{a}±0.04	6.3 0±0.03
Time						
0	68.55^{a}±0.16	20.25^{a}±0.05	8.38±0.04	3.43±0.05	0.11±0.01	6.43±0.08
7	67.38±0.11	20.21±0.08	8.38^{b}±0.04	3.43^{b}±0.05	0.11^{d}±0.01	6.43±0.08
14	66.26^{c}±0.34	19.15^{b}±0.06	8.22^{b}±0.06	2.45^{b}±0.03	0.25^{c}±0.10	6.35±00.05
21	63.21^{d}±0.30	19.10^{c}±0.04	7.18^{c}±0.07	4.55^{a}±0.05	0.29^{b}±0.01	6.25±0.04
28	62.50^{d}±00.26	18.03^{c}±0.05	6.15^{d} ±0.05	4.66^{a}±0.05	0.32^{a} ±0.01	6.28±0.05

abcd: Means on the same column with different superscripts are statistically significant ($p<0.05$).
MC= Moisture Content, CP= Crude Protein, EE= Ether Extract, TBA= Thiobarbituric acid

Table 3. *Microbial load of beef preserved with freezer and clay pots (cfu/g)*

Variable				
Parameter	**TVC**	**TCC**	**TAC**	**TFC**
Treatments				
T1	$7.5x10^{6a}$±1.56	$6.5x10^{3a}$ ±0.05	$6.7x10^{3a}$ ±1.32	$1.6x10^{5}$±0.55
T2	$5.6x10^{6b}$ ± 1.21	$4.3 x 10^{3b}$ ± 0.72	$3.6x10^{3b}$ ± 1.59	$1.2 x 10^{5}$ ±0.33
Time				
0	$5.70x10^{6a}$ ±0.52	$4.53x10^{3c}$ ±0.59	$4.63x 10^{3c}$ ±0.62	$1.30x10^{5}$±1.03
7	$5.75x 10^{6a}$ ±2.39	$4.55x 10^{3c}$ ±0.55	$4.69x10^{3c}$ ±1.08	$1.50x10^{5}$±4.29
14	$4.61x 10^{6b}$ ±0.79	$5.65x10^{3b}$ ±0.62	$5.73 x 10^{3b}$ ±1.59	$1.65x10^{5}$ ±1.91
21	$4.37x10^{6b}$ ±1.28	$6.68x10^{3a}$ ±0.48	$6.75x10^{3a}$ ±1.70	$2.00x10^{5}$ ±1.22
28	$4.25x10^{6b}$ ±1.59	$6.71x10^{3a}$ ±1.18	$6.79x10^{3a}$ ±1.71	$2.30x10^{5}$ ±1.33

abc: Means on the same column with different superscripts are statistically significant ($p<0.05$)
TVC = Total viable count, TCC = Total coliform count, TAC = Total anaerobic count, TFC= Total fungal count

Table 4. *Sensory characteristics of beef preserved with freezer and clay pot*

Variable							
Parameter	**Col.**	**Flv.**	**Odour**	**Tdn.**	**Jcn.**	**Tex**	**OA**
Treatments							
T1	6.75^{a}±0.10	5.60^{b}±1.40	3.20^{b}±1.40	6.60^{a}±1.31	6.52^{a}±006	5.80^{a}±0.10	6.10^{b}±1.30
T2	24.56^{b}±0.05	6.80^{a}±030	4.70^{a}±1.20	4.70^{b}±0.60	4.62^{b}±0.60	3.72^{b}±0.06	7.50^{a}±0.07
Time							
0	6.85^{a}±0.45	7.42^{a}±0.93	3.70^{d}±0.79	$0.79.4.00^{b}$±0.49	3.35^{b}±0.58	6.85^{a}±0.50	7.60^{a}±1.18
7	6.72^{a}±1.18	6.87^{a}±1.20	3.78+±1.30	4.20^{b}±0.91	5.92^{a}±0.34	5.60b±0.65	6.40^{b}±0.74
14	5.65^{b}± 0.83	5.83^{b}±0.84	4.82^{c}±1.23	5.50^{a}±1.54	3.70^{b}±1.28	5.50^{c}±0.93	6.30^{b}±0.93
21	5.52^{b}±070	5.78^{b}±1.38	5.84^{b}±1.38	4.75^{ab}±1.91	4.85^{ab}±1.65	4.42^{d}±0.84	5.2^{2}c±0.44
28	284.37^{c}±1.49	4.65^{c}±0.62	6.90^{a}±0.47	5.89^{a}±1.13	5.75^{a}±0.70	4.25^{d}±0.49	4.17^{d}±0.49

abcd: Means on the same column with different superscripts are statistically significant ($p<0.05$)
Col. = Colour, Flv. = flavour, Tdn. = Tenderness, Jcn. = Juiciness, Tex. = Texture, OA = Overall acceptability

The microbial load results of beef preserved with freezer and clay pot are shown on Table 3. There were significant ($p>0.05$) differences in the microbial load of beef with freezer (T1) furnishing higher ($p<0.05$) microbial values than clay pot (T2) with the exception of total fungal count (TFC) that was not significant ($p>0.05$) in the two treatments. The results further showed that total viable count (TVC) decreased ($p<0.05$) while total coliform (TCC) and anaerobic (TAC) counts increased ($p<0.05$) but no significant ($p>0.05$) difference in TFC as the time of preservation increased.

Beef preserved in Freezer (T1) was more tender with high texture and colour than that in the clay pot (T2) whereas, beef preserved in the clay pot had higher ($p<0.05$) flavour and was accepted more ($p<0.05$) than that of freezer even though it had higher ($p<0.05$) odour value Table 4.

4. Discussion

The decrease observed in meat colour in T2 could be due to reduced WHC as a result of heat treatment which increased the toughness of the meat. The beef in the claypot did not have high thermal shortening and cooking loss probably the water from the meat could not escape and was reabsorbed into the mat thereby increase the yield. As time increased colour, WHC and yield decreased while cooking loss thermal shortening and shear force values increased to a tolerable levels on 14th day beyond which the values were higher. These results agreed with the report of Apata (2009) and Apata (2011).Crude protein and ash were higher in T2 probably because of lower moisture which increased the concentration of the nutrients in the meat, however fat decreased which could be due to melting of fat as a result of heating. Since there was break down of fat, that might be responsible for increase in the value of TBA in T2 and as the time of preservation increased. These results were in agreement with the findings of Apata (2009) who reported that most of the chemical components of meat break down even in the freezer over a prolonged preservation. The decrease observed in TVC could be due to the fact that the environment was becoming unconducive to these microbes as the oxygen might have been used up gradually and anaerobic condition was developing thereby aiding the increase of both TCC and TAC which proliferate none in anaerobic environment, however there was no significant ($p>0.05$) increase in TFC as the time increased. The microbial loads; TVC, TCC and TAC decreased at 14^{th} day of preservation, TVC decreased while TCC and TAC increased further to 28^{th} day similar report was made by Apata (2010) that in the environment where both, TVC and either TCC or TAC coexist TVC decreased with time while either of the latter two increased due to change in environmental condition that would be detrimental to TVC due to reduction in oxygen concentration but favours either TCC or TAC as the environment would be rich in carbon dioxide.

These results might be due to the fact that protein content was higher and microbial was of beef in T2 was lower which could have increased the flavour of the meat thereby increasing its acceptability. These results is in agreement with the findings of Omojola (2008). The results however showed that cooked beef colour, flavour, texture and overall acceptability decreased as from 14^{th} day of preservation down to 28^{th} day while odour started to increase from the same day, the same day, however, tenderness and juiciness values did not have a particular pattern of increase. The decrease in colour, texture, flavour and overall acceptability could be due to activities of microbes and breakdown of protein as well as fat and increase of lipid oxidation (TBA) which are higher beyond 14^{th} day of preservation.

5. Conclusion

The results obtained from this study showed can be preserved in the local clay pot and still compared well with the conventional preservation method which is freezer. Clay pot preservation can be used in developing countries like Nigeria where power supply in still epileptic especially in the rural areas. It is however recommended that beef may not be preserved beyond 14^{th} days as most of the beef properties tested in this study started to disintegrate beyond that period of preservation.

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