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# Evaluation of Microbial Quality of Fresh Goat Meat Sold in Umuahia Market, Abia State, Nigeria

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**Abstract:** The evaluation of microbial quality of fresh goat meat sold in Umuahia market Abia State was carried out. A total of 40 samples of fresh goat meat were collected and analyzed for total aerobic plate count, coliform count, *Salmonella-Shigella* count and fungal count using nutrient agar, MacConkey agar, *Salmonella-Shigella* agar and potato dextrose agar respectively. The pour plate technique was employed. The total aerobic plate count ranged from 5.39±0.04 $Log_{10}$cfu/g to 5.48±0.05 $Log_{10}$cfu/g while the coliform count ranged 4.09±0.01 $Log_{10}$cfu/g to 4.47±0.05 $Log_{10}$cfu/g. The *Salmonella-Shigella* count ranged from 0±0.00 $Log_{10}$cfu/g to 2.43±0.02 $Log_{10}$cfu/g while the fungal count ranged from 3.18±0.02 $Log_{10}$cfu/g to 3.56±0.05 $Log_{10}$cfu/g. The microorganisms isolated from the fresh goat meat samples were *Bacillus* species, *Escherichia coli*, *Proteus* species, *Pseudomonas* species, *Salmonella* species, *Staphylococcus aureus*, *Streptococcus* species, *Aspergillus* species, *Penicillium* species and yeast. The result showed that goat meats were often contaminated with microorganisms due to unhygienic and poor sanitary conditions.

**Key words:** Evaluation, microbial, quality, goat, meat Umuahia, market

## INTRODUCTION

Meat is an important edible post mortem component originating from the live animals that are used as food by human. These animals include domesticated cow, buffalo, sheep, goat, camels and some wild animals. Meat is the most perishable of all important foods since it contains sufficient nutrient needed to support the growth of microorganisms (Magnus, 1981). The chief constituents of meat are water, protein and fat, phosphorus, iron and vitamins are also contained in meat. The major primary unit of meat is called carcass. It represents the ideal meat after head, hide, intestine, blood. The edible parts of a carcass include lean flesh and edible glands or organs such as heart, liver, kidney, tongue and brain. Meat is considered as the most nutritive source of protein consumed by humans. Age and sex of the animal has a major influence on the quality of meat that is produced from animals. Most meat have high water content corresponding to the water activity approximately 0.99 which is suitable for microbial growth (Rao *et al*., 2009).

The domestic goat (*Capra aegagrus hircus*) is a subspecies of goat domesticated from the wild goat of southwest Asia and Eastern Europe. The goat is a member of the Bovidae family and is closely related to the sheep as both are in the goat-antelope subfamily Caprinae. There are over three hundred distinct breeds of goat. Goats are one of the oldest domesticated species. Goats have been used for their milk, meat, hair and skins over much of the world. In the twentieth century they also gained in popularity as pets. Female goats are referred to as *does* or *nannies*, intact males as bucks or billies and their offspring are kids. Castrated males are wethers. Most goats naturally have two horns, of various shapes and sizes depending on the breed. All goats have horns unless they are "polled" meaning they have one parent with a dominant polled gene. Their horns are made of living bone surrounded by keratin and other proteins and are used for defense, dominance and territoriality. Goats are ruminants. They have a four-chambered stomach consisting of the rumen, the reticulum, the omasum and the abomasum. The females have an udder consisting of two teats. Goats have horizontal slit-shaped pupils, an adaptation which increases peripheral depth perception. Both male and female goats have beards and many types of goat (most commonly dairy goats, dairy-cross boers and pygmy goats) may have wattles, one dangling from each side of the neck (Smith, 1994; Taylor, 1998; Payne and William, 1999).

Goat meat is the meat of the domestic goat *(Capra aegagrus hircus)*. It is often called chevon or mutton when the meat comes from adults and cabrito or kid when from young animals. Goat meat is the most widely consumed meat in the world and has been for centuries. It is a traditional meat throughout many regions including the Middle East, Mediterranean, parts of Africa, the Caribbean and throughout South-East Asia. Though it's the most popular meat in the world it's very unlikely you'll find goat meat in your supermarket. Specialist

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butchers will either have it on hand or source some for you. Some farmers markets may sell it. Goat meat can be treated much like lamb. It is lean and low in fat, so careful handling is needed (Rezoui *et al*., 2008; Fowler, 2008).

Goat can be prepared in a variety of ways such as being stewed, curried, baked, grilled, barbecued, minced, canned, fried, or made into sausage. Goat jerky is also another popular variety (Fletcher, 2008). Goat has a reputation for strong, gamey flavor, but can be mild depending on how it is raised and prepared (Alford, 2009). Despite being classified as red meat, goat is leaner and contains less cholesterol and fat than both lamb and beef. Therefore it requires low-heat and slow cooking to preserve tenderness and moisture (Kunkle and Dwyer, 2004).

Meat is considered to be spoiled when it is unfit for human consumption. Meat is subjected to changes by its own enzyme, by microbial action and its fat may be oxidized chemically. Microorganisms grow on meat causing visual, textual and organoleptic changes when they release metabolites (Jackson and McGowan, 2001). Among the factors that affect microbial growth in meat are the intrinsic and extrinsic factors (Rombout and Nout, 1994), however the factors having the greatest influence on the growth of microorganisms in meat and meat products are the storage temperatures, moisture and oxygen availability (Forest *et al*., 1985; Frazier and Westhoff, 2004). Meat, the flesh of animals suitable for use as food has a very high nutritional value and moisture content with pH value of 5.4, could serve as an excellent medium for microbial contamination growth and spoilage (Lawrie, 1985).

The aim of this work is to evaluate the microbiological quality of goat meat sold in Umuahia market.

## MATERIALS AND METHODS

**Sample collection:** Fourty samples of fresh goat meat were purchased from Umuahia market, Abia State, Nigeria. The samples were aseptically collected with sterile sampling containers, labeled and transported in ice packed cooler to the laboratory. They were analyzed immediately on reaching the laboratory.

**Chemical reagents:** The chemical reagents employed in the study were of analytical grade and were products of BDH chemicals, Poole's England and Sigma Chemical Company St. Louis Missouri, USA. The microbiological media used were products of Oxoid Laboratories, England. They included nutrient agar used for the estimation of total heterotrophic aerobic bacteria, purification of isolates and for stock culture; potato dextrose agar used for the isolation of fungi, MacConkey agar for the isolation of coliforms, blood agar for the isolation of Streptococcus and *Salmonella-Shigella* agar for the isolation of *Salmonella* and *Shigella*.

**Enumeration of total heterotrophic bacteria and fungi:** Samples of the goat meat were serially diluted in ten folds. Total viable heterotrophic aerobic counts were determined using pour plate technique. Then the molten nutrient agar, potato dextrose, agar MacConkey agar, blood agar and *Salmonella-Shigella* agar at 45°C were poured into the Petri dishes containing 1 mL of the appropriate dilution for the isolation of the total heterotrophic bacteria and fungi, coliforms, *Streptococcus* and *Salmonella-Shigella* respectively. They were swirled to mix and colony counts were taken after incubating the plates at 37°C for 48 h and preserved by subculturing the bacterial isolates into nutrient agar slants which were used for biochemical tests.

**Characterization and identification of isolates:** Bacteria isolates were characterized and identified after studying the Gram reaction as well as cell micro morphology. Other tests performed were spore formation, motility, oxidase and catalase production; citrate utilization, Oxidative/Fermentation (O/F) utilization of glucose; indole and coagulase production, starch hydrolysis, sugar fermentation, methyl red-Voges Proskaur reaction and urease production. The tests were performed according to the methods of (Cheesbrough, 2002; Adeoye, 2007; Agwung-Fobellah and Kemajou, 2007; Ochei and Kolhatkar, 2007). Microbial identification was performed using the keys provided in the Bergeys Manual of Determinative Bacteriology (1994).

Fungal isolates were examined macroscopically and microscopically using the needle mounts technique. Their identification was performed according to the scheme of Barnett and Hunter (1972) and Larone (1986).

## RESULTS

The results obtained from the fresh meat samples are shown in Tables 1 and 2. Table 1 shows the mean counts of microorganisms isolated from the fresh goat meat samples. The ranged from 5.39±0.04 $Log_{10}$cfu/g to 5.48±0.05 $Log_{10}$cfu/g while the coliform count ranged 4.09±0.01 $Log_{10}$cfu/g to 4.47±0.05 $Log_{10}$cfu/g. The *Salmonella-Shigella* count ranged from 0±0.00 $Log_{10}$cfu/g to 2.43±0.02 $Log_{10}$cfu/g while the fungal count ranged from 3.18±0.02 $Log_{10}$cfu/g to 3.56±0.05 $Log_{10}$cfu/g. The ANOVA, $p>0.05$ showed that there was no significant difference in the mean counts of the total aerobic plate count, coliform count and fungal count respectively among the weeks while the ANOVA, $p<0.05$ showed that there was significant difference in the *Salmonella-Shigella* mean count among the weeks. Table 2 shows the microorganisms isolated from the fresh goat meat samples and their percentage occurrence. The bacterial genera isolated showed that *Bacillus* species had the highest percentage occurrence of 20.7% and *Salmonella* species had the least

Table 1: Mean counts of microorganisms isolated from the goat meat

| | $Log_{10}$cfu/g | | | |
|---|---|---|---|---|
| | TAPC | CC | SSC | FC |
| Week 1 | 5.39±0.04 | 4.09±0.01 | 2.26±0.03 | 3.18±0.01 |
| Week 2 | 5.48±0.05 | 4.47±0.05 | 2.21±0.01 | 3.56±0.05 |
| Week 3 | 5.46±0.03 | 4.47±0.04 | 2.43±0.02 | 3.46±0.03 |
| Week 4 | 5.43±0.02 | 4.28±0.03 | 0.00±0.00 | 3.48±0.04s |

Key: TAPC = Total Aerobic Plate Count, CC = Coliform Count, SSC = *Salmonella Shigella* Count, FC = Fungal count

Table 2: Microorganisms isolated and their percentage occurrence

| Bacteria | No. of isolates | Percentage occurrence |
|---|---|---|
| *Pseudomonas* species | 16 | 18.4 |
| *Staphylococcus aureus* | 9 | 10.3 |
| *Bacillus* species | 18 | 20.7 |
| *Escherichia coli* | 15 | 17.2 |
| *Salmonella* species | 7 | 8.0 |
| *Proteus* species | 8 | 9.2 |
| *Streptococcus* species | 14 | 16.1 |
| Total | 87 | 100.0 |
| **Fungi** | | |
| *Aspergillus* species | 19 | 35.2 |
| *Penicillium* species | 18 | 33.3 |
| Yeast | 17 | 31.5 |
| Total | 54 | 100.0 |

percentage occurrence of 8.05%. Among the fungi isolated, *Aspergillus* species had the highest percentage occurrence of 35.2% and Yeast species had the least percentage occurrence of 31.5%.

## DISCUSSION

The high microbial count enumerated from fresh goat meat samples indicated that the meat samples were contaminated. Microorganisms can easily be introduced either in the pre or post processing stages of meat processing (Johansson, 1983).

The high coliform count observed from goat meat is assumed to be an indicator of fecal contamination. It is likely that the observed increase of fecal bacteria is due to problem associated with removal of the fleece and its coming into contact with the surface of carcass (Ozlem, 2005). Chaubey *et al.* (2004) enumerated the coliform in the majority of the meat samples and suggested that raw meat and meat products should be handled under strict hygienic condition and stored in cool places to avoid contamination and safe guard the health of consumers.

The high microbial load could be from the fleece of goat to the carcass surfaces during hide removal (Bell *et al.*, 1993). The area of highest contamination was those sites where cuts were made through the skin (Bell and Hathaway, 1996). The finding of present study is a reflection of the unhygienic practices of meat processing in the developing countries (Bhandare *et al.*, 2007). It has been observed that the inner tissues of healthy animals are sterile, however, contamination comes from external sources during bleeding, handling and processing. During bleeding, skinning and cutting, the main sources of microorganisms are the exterior of the animal which includes the hide, hooves and hair and the intestinal tract. The exterior of the animal harbours large numbers and many kinds of microorganisms from the soil, wash water, feed and manure, as well as its natural surface flora and the intestinal contents contain the intestinal organisms. Knives, cloths, air environment of the abattoir, slaughter-slabs, hands and clothing of the workers and the physical facilities can serve as intermediate sources of contaminants. It has also been shown that during handling, contamination comes from carts, boxes or other containers, other contaminated meat, air and personnel. These resulted in the increase in the microbial load of the fresh goat samples (Lawrie, 1984; Rombout and Nout, 1994; Frazier and Westhoff, 2004). Retail cut could also result in greater microbial load because of the large exposed surface area, more readily available water, nutrient and greater oxygen penetration available (Forest *et al.*, 1985). Hence smaller retail cuts displayed are conducive for microbial growth and proliferation which leads to spoilage of the meat (Agnes, 1995).

The fresh goat meat sold to the public in open markets is grossly contaminated with coliform bacteria as well as other bacteria and fungi. This work has revealed that the fresh goat meat sold in Umuahia market is contaminated by both Gram positive and Gram negative bacteria. The bacteria isolated were *Pseudomonas* species, *Staphylococcus aureus*, *Bacillus* species, *Streptococcus* species, *Escherichia coli*, *Salmonella* species and *Proteus* species. The organisms isolated are in line with the work of Turtura (1991); Adak *et al.* (2005); Clarence *et al.* (2009). They reported that Gram negative bacteria account for approximately 69% of the cases of bacterial food-borne diseases. The presence of these organisms in the goat meat is indicative of public health hazard and gives a signal of the possible occurrence of food borne intoxication and infection. This also implies that these meats are viable source of various diseases. Some of these diseases could spread and acquire epidemic status which poses serious health hazards.

*Staphylococcus aureus*, which is a normal flora of the body, indicates contamination from handlers. The organism can pass onto food during harvesting, processing or even storage. It is the major cause of food poisoning known as staphylococcal food poisoning. The poisoning is caused by the ingestion of an enterotoxin produced, which is characterized by diarrhea and vomiting (Singleton, 1995; Frazier and Westhoff, 2004; Eze *et al.*, 2008).

*Bacillus* species are Gram positive aerobic spore-formers and most members of the genus are saprophytic prevalent in the soil, water and air and on vegetation. *Bacillus cereus* and *Bacillus subtilis* are the most encountered in the group. *Bacillus cereus* causes food poisoning by the production of an enterotoxin (Thomas, 1994; Brooks *et al*., 2004).

*Escherichia coli* is an enteric organism and its presence is an indication of faecal contamination of the samples. This may attributed to improper sanitary condition during processing of the meat from the water supply, unsterilized utensils and contamination by flies. It causes gastroenteritis in infants and young children (Brooks *et al*., 2004). The presence of other organisms is as a result of improper handling butchers, when the meat is transported to markets, storage, flies and our environment. However, the processors/or handlers should observe strict hygienic measures so that they may not serve as source of chance inoculation of microorganisms and fecal contamination of fresh meats and other meat products. Also irrespective of the presence of these microorganisms in the fresh meat analyzed, it is believed that cooking processes and hygiene will greatly reduce the microbial load to harmless level. Thorough cooking as well as good hygiene in order to prevent contamination of food eaten raw is also important (Amann *et al*., 1995). This also demonstrates a potential health risk as the organism is pathogenic and causes complication in children (Taulo *et al*., 2008).

It is therefore necessary that fresh goat meat for consumption purposes should be adequately cooked before consumption. The National Agency for Food and Drug Administration and Control (NAFDAC) and other sanitary authorities should ensure and enforce strict compliance to the recommended food standards as regards to the processing and sales of fresh and packaged goat meat products. Meat handlers and sellers should be educated on the adverse effect of lack of proper personnel hygiene and sanitation.

Good manufacturing practice should be adhered to strictly by butchers and those selling the meat. Veterinary doctors should inspect the animals to be slaughtered before the meat is sold to the general public.

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