ASSESSEMENT OF THE EFFICACY OF *ZINGIBER OFFICINALE* AND *CURCUMA LONGA* IN SHELF LIFE EXTENSION OF MEAT

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Abstract: The preservation of meat products remain a significant challenge due to their high perishability and susceptibility to microbial contamination and oxidative spoilage. In response to growing concerns over the health implications of synthetic preservatives, this study aimed to assess the efficacy of some locally available natural spices; ginger (*Zingiber officinale*) and turmeric (*Curcuma longa*) in extending the shelf life of meat. The fresh raw meat were divided into four parts. Three parts were treated with ginger, turmeric, combination of ginger and turmeric respectively. The other part was the control part, which was treated with water alone. The meat samples were kept at room temperature for 72hours and at every 24hours the meat samples were assessed. The stored meat samples were grinded and inoculated into nutrient agar, mannitol salt, macconkey, salmonella shigella and potato dextrose agar respectively and were incubated at 37°C for 24hours except for PDA which was incubated at 30°C for 7days. The isolates were identified phenotypically including morphological, biochemical test, Gram staining and genotypic characterization including DNA extraction using ZR Fungal/Bacterial DNA MINIPREP, Electrophoresis, 16SrRNA gene amplification and sequencing. The results revealed the isolates as *Salmonella enterica* and *Staphylococcus aureus.* The meat samples treated with all the assayed samples including their combination, exhibited a significant reduction in microbial growth and lipid oxidation compared to untreated controls sample at $p < 0.05$. The natural preservatives also helped in maintaining desirable sensory qualities throughout the storage the storage periods. Among all treatments, the combined spices showed the most effective performance in inhibiting spoilage and extending shelf life giving $\geq 0.1 \times 10^4$ CFU/ml. These findings support the potential application of these spices especially in their combined form in both rural and commercial settings where refrigeration is limited, offering a natural, affordable and accessible solution to meat spoilage.

Keywords: Curcuma Longa, Efficacy, Meat, Preservation, Shelf life*, Zingiber Officinale.*

I. INTRODUCTION

Meat preservation was aimed at extending the shelf life of meat products while maintaining their safety, nutritional value and sensory qualities. Meat is highly perishable in nature which is as a result of its high moisture content, rich nutrient composition and neutral pH. These factors create an ideal environment for spoilage microorganisms to grow in the meat and causes oxidative rancidity to occur [1]. These factors deteriorate meat quality thereby posing significant health risks to consumers and causes economic losses to producers. Traditional methods of preservation including refrigeration, freezing,

salting, smoking and the use of synthetic preservatives, have been widely employed in meat preservation. The demand for neutral, organic and chemical-free food products has spurred interest in exploring natural alternatives for meat preservation. Several spices have been utilized not only for their flavour-enhancing properties but also for preservation of food due to their medicinal and antimicrobial potentials.

Spices such as ginger *(Zingiber officinale)* and turmeric *(Curcuma longa)* are most commonly used for centuries in traditional medicine and culinary practices across various cultures. These spices contains bioactive compounds, including gingerol in ginger and curcumin in turmeric and have been scientifically proven to exhibit significant antimicrobial and antioxidant activities [2],[3]. These properties make them promising candidates for natural meat preservation, as they can inhibit the growth of spoilage microorganisms and delay oxidative rancidity, thereby extending their shelf life.

Historically, spices have been used to preserve food before the advent of modern preservation techniques. For instance, garlic has been used for its antimicrobial properties, while turmeric has been valued for its antioxidant and anti-inflammatory effects. Ginger, on the other hand has been used to enhance flavour and inhibit microbial growth. In recent years, the interest in the utilization of these traditional practices has increased driven by the growing awareness of the potential health risks associated with synthetic preservatives, such as sodium nitrite and butylated hydroxyanisole (BHA). These synthetic preservatives have been associated to various health issues, including cancer and allergic reactions, prompting consumers to seek safer and more natural alternatives [4].

The ability of local spices including ginger and turmeric to preserve meat can be attributed to their ability to inhibit the growth of spoilage microorganisms and prevent oxidative rancidity. Several microorganisms including *Salmonella* spp. *Pseudomonas* spp. and *Brochothrix thermosphacta* have linked to the deterioration of meat quality which lead to off-flavours, discoloration and texture changes [5]. The bioactive compounds present in these spices including ginger, turmeric and garlic have been reported to disrupt microbial cell membranes, inhibit enzyme activity and scavenge free radicals, thereby preventing microbial growth and lipid oxidation [6].

Several studies have investigated the antimicrobial and antioxidant properties of these spices. For instance, [2] findings revealed the ability of ginger to inhibit the growth of foodborne pathogens such as *Escherichia coli* and *Staphylococcus aureus* due to the presence of gingerol and shogol. [3] reported that turmeric, rich in curcumin, demonstrated strong antioxidant activity, effectively reducing lipid oxidation in meat products. These findings highlight the potential of these spices as natural preservatives in meat.

II.   MATERIALS AND METHODS

MATERIALS

Source of Samples:

The fresh raw meat utilized in the study was purchased from the butcher at Eke Agbani local market in Enugu State, Nigeria. The local spices *Zingiber officinale* (ginger) and *Curcuma longa* (tumeric) were purchased from spices vendor in main market Enugu State, Nigeria.

Preparation of Sample

The local spices were peeled and washed with sterile water. They were dried, grinded using home blender (corona), sieved using a muslin cloth and then stored in a sterile container prior to use.

The fresh raw meat were divided into four parts. Three parts were treated with ginger, turmeric, combination of ginger and turmeric respectively. The other part was the control part, which was treated with water alone.

Meat Storage Process:

The meat samples were kept at room temperature for 72hours and at every 24hours the meat samples were assessed.

Sample Inoculation Process

The stored meat samples were pounded using a mortar and pestle. Thereafter, they were inoculated into nutrient agar, mannitol salt, macconkey, salmonella shigella and potato dextrose agar respectively and were incubated at 37°C for 24hours except for PDA which was incubated at 30°C for 7days.

Identification of the Isolates:

The isolates were identified phenotypically by morphological characterization, biochemical test, Gram staining and genotypic characterization such as DNA extraction using ZR Fungal/Bacterial DNA MINIPREP, Electrophoresis for DNA and PCR, 16SrRNA gene amplification and sequencing.

The treated meat samples were also evaluated by observing their colour, odour, texture and overall acceptability.

Statistical Analysis:

The data which was obtained from the study were analysed using IBM Statistical Product and Service Solution (SPSS), version 18. One-way analysis of variance (ANOVA) and the mean values were considered statistically significant compared between and within the groups at $P < 0.05$.

III. RESULTS AND DISCUSSION

Identification of the Isolates

The phenotypic characterization revealed the isolates as *Salmonella* spp. and *Staphylococcus* sp. The molecular characterization confirmed the bacterial isolates as *Salmonella enterica* and *Staphylococcus aureus* (Table 2). The Gel image showing the amplification of the internal transcribed spacer (ITS) of *Salmonella enterica* MS and *Staphylococcus aureus* MS were at 250bp. Lane M (50bp DNA ladder) and at 500bp. Lane M (50bp DNA ladder) respectively (Figure 1 & 2).

The finding is similar with [7] and [8] who isolated these organisms from stored meat sample. In contrary [9] didn't isolate these organism in the meat stored with the same local spices.

The presence of *Salmonella enterica* and *Staphylococcus aureus* in the stored meat indicated significant microbial contamination likely due to inadequate hygiene during processing and storage. Their isolate from the meat samples poses a serious public health risk due to their potential to cause foodborne illnesses.

TABLE 1: PHENOTYPIC CHARACTERIZATION OF THE ISOLATES

	Growth Appearance Media					Gram reaction	Biochemical Test							Suspected organisms
Isolate	NA	SSA	MAC	MSA	PDA		Catalase	Oxidase	Coagulase	Indole	Urease	Methyl red	VP	
1	Medium sized-off white, Moist smooth colonies	Transparent colony with black centre	-	-	-	-ve rod shaped bacilli	+	-	-	-	-	+	-	*Salmonella sp*
2	Colourless convex smooth colonies	Colourless colony with black spot	-	-	-	-ve rod shaped bacilli	+	-	-	-	-	+	-	*Salmonella sp*
3	Large golden yellow colonies	-	-	Large golden yellow colonies	-	+ve cocci in cluster	+	-	+	-	+	+	+	*S. aureus*

Key: NA= Nutrient agar, SSA= Salmonella shigella agar, MAC= MacConkey agar, MSA= Mannitol salt agar, PDA= Potato dextrose agar, VP= Voges proskauers

TABLE 2: MOLECULAR CHARACTERIZATION OF THE ISOLATES.

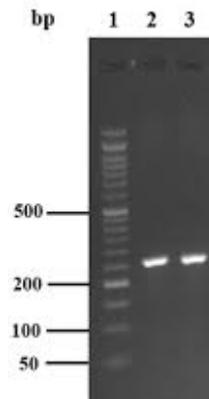| Isolate code	Kingdom	Organism	% Similarity	Accession Number
MS2	Bacteria	*Salmonella enterica*	93.1	CQ108275.1
MS2	Bacteria	*Salmonella enterica*	93.1	CQ108275.1
MS3	Bacteria	*Staphylocoocus aureus*	95	AM990992.1

Figure 1: The amplification of the internal transcribed spacer (ITS) of *Salmonella enterica* MS at 250bp.(Lane M is 50bp DNA ladder)


Figure 2: The amplification of the internal transcribed spacer (ITS) of *Staphylocoocus aureus* MS at 500bp. (Lane M is a 50bp DNA ladder)

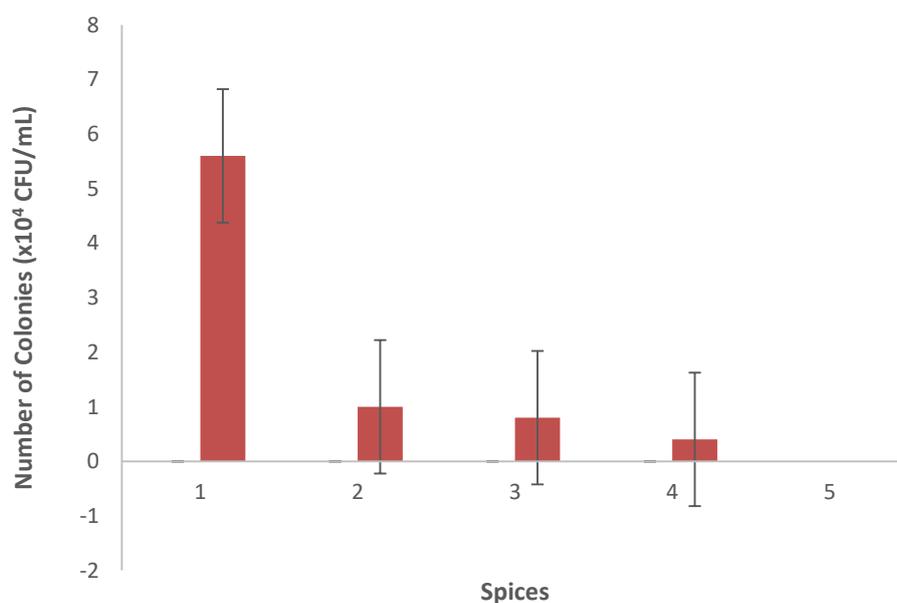**The Effect of Assayed Spices on the Stored Meat**

The assayed spices gave significant effect in the preservation of the meat stored in all the assayed periods when compared to that of the control (meat stored with water alone). The effect of the spices was more effective at 24hours storage. Although bacterial colonies increased as the periods were extended, yet the spices including in its combined state still have significant effect on the stored meat. There was significant difference with the effect of the spices in the combined form and that of the individual spices at $p < 0.05$ as it recorded ± 0.1 x 10^4CFU/ml across the assayed periods. [10] reported similar result as they revealed the effect of these spices in meat preservation. In contrary, [11] reported inability of these spices to have antimicrobial effect on the stored meat samples.

The ability of ginger to preserve the meat up to this period could be attributed to the findings of [2] who reported that ginger can inhibit the growth of foodborne pathogens by disruption of microbial cell membranes and inhibitor of enzyme activity, leading to cell death. The ability of turmeric to be effective in the meat preservation could be attributed to the presence of curcumin which has been reported to inhibit the growth of a wide range of microorganisms by the disruption of the microbial cell membranes and interference with cellular signalling pathways [3]. As [12] also reported that turmeric significantly reduced lipid peroxidation in meat products thereby extending their shelf life.

The combination of spices gave significant effect on the stored meat in all the periods at $p > 0.05$. This result is in line with [5] and [12] reports that stated that combining spices in preservation of meat will significantly reduce lipid oxidation in meat products, outperforming individual extracts by targeting multiple microbial pathways.
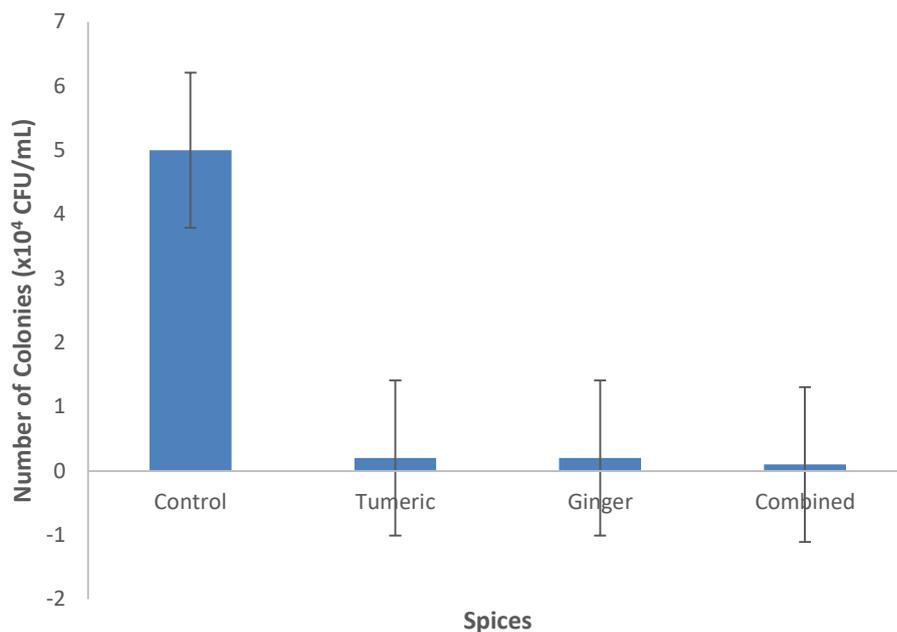
Figure 3: Effect of the assayed spices on the meat stored for 24hours interval

Figure 4: Effect of the assayed spices on the meat stored for 48hours interval
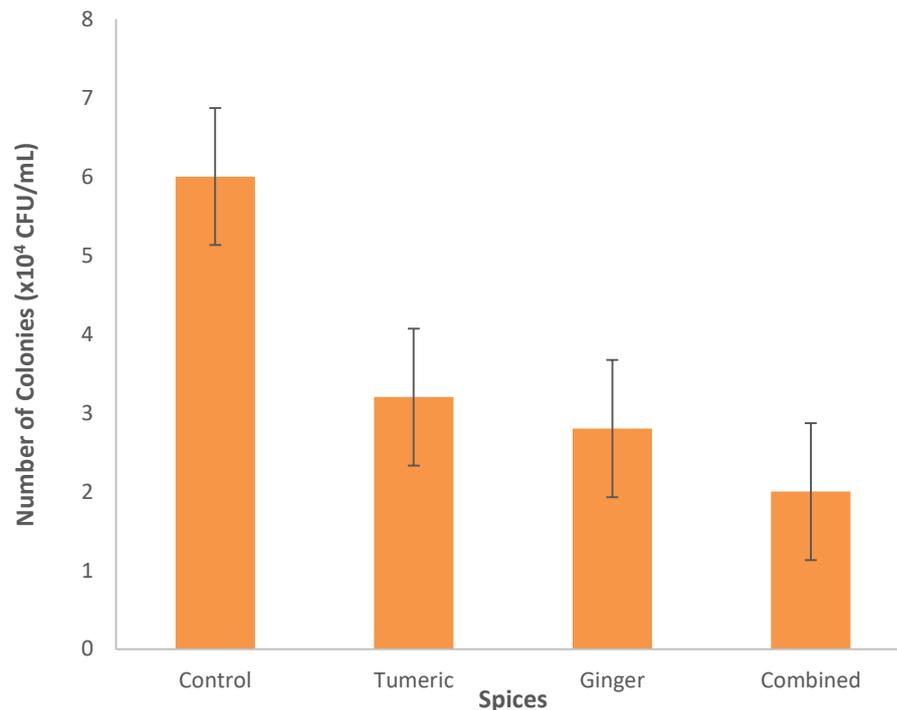
Figure 5: Effect of the assayed spices on the meat stored for 72hours interval

Sensory Evaluation of the Meat Preserved at Various Periods

The sensory evaluation of the treated meat across the periods (Table 3) revealed the efficacy of these spices. At 24hours, the control sample changed in colour and texture with a bit foul odour. The spices were able to preserve the meat up to 72hours as the colour was intact and no bad odour was detected. At 48 and 72hours the texture of the meat was a bit softer. The result was similar with the result of [4] and [5] that reported effect of these spices on meat. In contrary, [13] reported these local spices not effective as it did not significantly reduce microbial contamination.

The ability of these spices both individual and their combination to have the efficacy to preserve the meat up to assayed period could be as a result of the presence of bioactive compound in ginger (gingerol, shogaol and zingerone) and turmeric (curcumin) as they have been reported to inhibit microbial growth and delay lipid oxidation in meat product [2], [3]. The combination efficacy could be attributed to the complementary mechanisms of action of their bioactive compound [12]

TABLE 3: Sensory Evaluation of the Meat Preserved At Various Periods

Local spices				
Periods (h)	Meat + water (control)	Meat + turmeric	Meat + ginger	Meat+ turmeric+ ginger
24	A bit foul odour noticed, no colour and texture change	No foul odour was noticed, no colour and texture change	No foul odour was noticed, no colour and texture change	No foul odour was noticed, no colour and texture change
48	Foul odour noticed, no colour change, slightly change in texture	No foul odour noticed, no colour change but there is a slightly change in texture	No foul odour, no colour change but there is a slightly change in texture	No foul odour, no colour change, slightly change in texture
72	Higher foul odour observed, colour changes to black texture becomes very soft	No foul odour noticed, no colour change, slightly change in texture	No foul odour, no colour change and slightly change in texture	No foul odour, no colour change and slightly change in texture

IV. CONCLUSION

Ginger and turmeric especially in combination are highly effective natural preservatives. They significantly reduce bacterial growth, maintain sensory integrity and enhance shelf life of meat under non-refrigerated conditions for assayed periods. These findings support their potential application in both rural and commercial settings where refrigeration is limited, offering a natural, affordable and accessible solution to meat spoilage.

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