

*Full Length Research paper*

# Production proximate analysis and shelf life studies of ready-to-eat rice and kilishi

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**Accelerated shelf life studies ( $50 \pm 2^\circ\text{C}$ ,  $27 \pm 2^\circ\text{C}$ ) were carried out on meal -ready-to-eat (RTE) rice and "Kilishi" which were prepared and packaged in aluminum foil and high density polyethylene (50  $\mu\text{m}$  gauge). Chemical, microbiological and proximate analysis of the product was carried out to ascertain the quality and safety of the meal. Total microbial load of the product at accelerated shelf life ranged from  $2 \times 10^2$  -  $4 \times 10^2$  CFU/g. FFA values, a measure of rancidity, were in the range of 1.2 and 2.1%. Proximate composition of Kilishi was: moisture (9.75), fat (18.10), ash (7.10), protein (57.02) and carbohydrate (8.05); and rice, moisture (10.8), fat (4.0) ash (3.3) protein (7.4) and carbohydrate (74.0). Also proximate analysis showed that rice and Kilishi are nutritionally complementary.**

**Key words:** Kilishi, rice, convenience, proximate composition, shelf life.

## PRACTICAL APPLICATION

The requirement for convenience foods resulted from the need to spend less time and energy in the kitchen preparing meals. However it is imperative that the kind of food to be developed into convenience food should be easy to prepare, meet both energy and nutritional requirements, and familiar to consumers so as to enhance wide acceptability. This led to the identification of rice and kilishi (dried meat) as suitable foodstuff for development into convenience food which would help travelers and tourists in the hospitality industry as well as military men during combat scenarios.

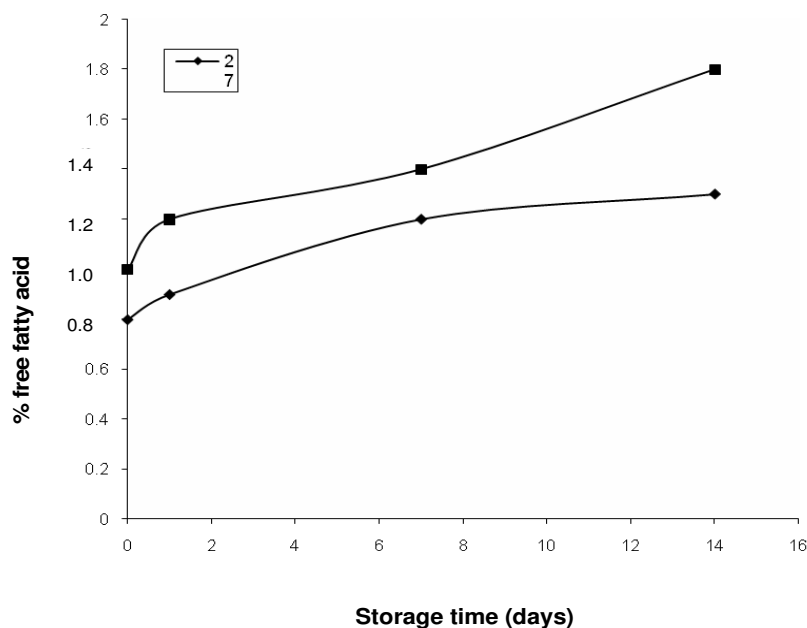
## INTRODUCTION

Rice, cereal grain is the main food of half of the world's population. Rice is grown in many countries, although it originated from Asia (Okaka, 1997). In Nigeria, rice is usually eaten after simple cooking although some are ground into flour and used as ingredient in other cooked foods. Rice can also be developed into convenience food. Enwere (1998) reported that rice is not a complete food from nutritional standpoint due to its low protein

Content, hence its combination with other foods of high protein content is nutritionally complementary. The requirement for convenience foods resulted from the need to spend less time and energy in the kitchen preparing meals. However, the kind of food to be developed into convenience food has to be capable of supplying energy and meet basic nutritional requirement, easy to prepare and familiar to consumers to enhance wide acceptability of the meal. This led to identification of rice and kilishi (sundried meat) as suitable food products for development into convenience food. According to Mothershaw et al. (2003), dried foods are ideal for use during war for military rations, for backpackers and for camping groups. Dried products have several advantages namely, they have lower mass, need less storage space and do not require refrigeration.

Kilishi is a traditional sun-dried meat product generally found in West Africa, particularly peculiar to the Northern part of Nigeria. The product appears to have been developed as a means of preserving meat in the absence of modern facilities for long storage by the early Fulani and Hausa herdsman in the Northern part of West Africa (Alonge and Hiko, 1981). Rice was selected for its high carbohydrate content, its universal acceptability and consumption, and kilishi for its high protein and fat (calorie) content, its satiety, lightness in weight and shelf stability. Meal-ready-to eat (RTE) rice is a present invention for

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**Figure 1.** Effect of storage temperature on % free fatty acid (FFA) value of kilishi.

making ready to eat shaped rice products having a texture comprised of visible fully cooked rice grain. This, meal - ready-to-eat rice is processed from raw rice into a shelf stable product, and can be re-prepared within 5 min with boiling water. Kilishi was prepared from raw meat and packaged in 50  $\mu\text{m}$  gauge polyethylene which makes the handling and marketing of the product very convenient.

Shelf life of various food products depend on the type of food, constituents and storage condition, RTE rice and kilishi would also be affected by these factors mentioned. Shelf life determination can be carried out in the laboratory by accessing the quality of the food when stored under specific storage condition (Pomeranz and Meloan, 1996).

Consequently, the objective of this research was to develop a convenience food which can be used by travelers, tourists, military men during combat situations and operational scenarios. Such food requires minimal time of preparation, light in weight and easy to carry, and is capable of supplying basic nutritional requirement.

## MATERIALS AND METHODS

Fresh cow beef and other ingredients such as defatted groundnut paste, garlic, onions, salt, sugar, ginger, seasonings, dried pepper, flavourings, and "Uncle Bens" rice were obtained from Bodija market, Ibadan, Oyo State, Nigeria.

### Kilishi and ready-to-eat (rte) rice preparation

Kilishi was prepared by partially drying thin sheets of quality beef in the sun followed by marinating in slurry of ingredient; defatted

groundnut paste, water, garlic, onions, ginger, salt, oil, sugar, seasonings before a second drying and roasting (Igene et al., 1990; Musonge and Njolai, 1994). Kilishi was packaged in a hermetically sealed high density polyethylene (50  $\mu\text{m}$ ).

Ready to eat (RTE) rice was prepared by cooking raw "Uncle Bens" rice using rice to water ratio 1:3) for about 40 min. Ingredients such as tomato paste, flavourings, oil, dried pepper, garlic, onions, seasonings, ground turmeric were added to the cooking water, during rice preparation. The cooked rice was dried in a Gallenhamp cabinet drier (Model OV size Two Oven) for about 6 h at 60°C after which it was allowed to cool. The cooled rice was mixed with dried garlic, dried pepper, ground turmeric and seasonings to enhance the taste when prepared for consumption. The dried rice (10.8%) was packaged in aluminium foil and subsequently sealed in high density polyethylene (50  $\mu\text{m}$  gauge) package. The RTE rice and kilishi were stored and analyzed at ambient ( $27 \pm 2^\circ\text{C}$ ) and elevated temperature ( $50 \pm 2^\circ\text{C}$ ) condition for 1, 7, 14 days.

### Microbiological evaluation

Microbial count of the kilishi and RTE rice samples were determined using potato Dextrose Agar for fungal count Oxoid CM727, and Macconkey Agar for coliform count (Meynelle and Meynelle, 1970). Samples were diluted in ringer solution and plated in duplicate using the surface plating method. The plates were incubated at optimum temperature of 37°C for coliform and at 30°C for fungi for 48 h. After which the counting was done and mean readings were recorded.

### Rancidity test/lipid oxidation analysis

Percentage free fatty acid (%) of kilishi was determined according to the method of AOAC (1990) (Figure 1). Fat extracted from kilishi was dissolved in the mixed neutral solvent (containing diethyl ether, alcohol, phenolphthalein solution and sodium hydroxide) and titrated with aqueous sodium hydroxide. The titre value obtained

**Table 1.** Proximate composition of kilishi and meal-ready-to eat rice.

Sample	Moisture	Fat	Ash	Protein	Carbohydrate
Kilishi	9.75	18.10	7.10	57.02	8.05
RTE rice	10.80	4.00	3.80	7.40	74.00

was used in determining the percentage free fatty acid (FFA), as a measure of rancidity.

### Proximate analysis

Protein, fat, moisture and ash were determined using AOAC (1990) methods. Carbohydrate was obtained by difference. Moisture determination was done by drying samples in an oven at 105°C for three hours. Dried samples were ground and used for determination of crude protein by kjeldahl method to obtain the nitrogen content which was multiplied by 6.25 (a constant for conversion of free nitrogen content to crude protein). Crude fat was determined by hydrolysis method using soxhlet apparatus and ash by heating at 600°C in a muffle oven for 8 h. All analyses were performed in duplicate.

### Statistical analysis

Data obtained were subjected to analysis of variance (ANOVA) using SAS (1987). Standard deviation and average values were calculated. Statistical significance was accepted at  $p < 0.05$ .

## RESULTS AND DISCUSSION

Proximate composition (Table 1) showed that kilishi has high protein content (57.02%) when compared with fresh meat. According to Ihekoronye and Ngoddy (1985), the protein content of fresh meat was 19%. This indicates that processing meat into kilishi improves the percentage protein of the product thus increasing nutrient density. The high protein content of kilishi may have been contributed by the groundnut cake paste, a major ingredient in kilishi production which has 55.85% crude protein according to Badau et al. (1997).

The high protein content of kilishi makes it suitable to be combined with rice which has low protein content but high carbohydrate content, making kilishi and rice to be nutritionally complementary. High carbohydrate content of the meal-ready-to eat rice though obtained by difference showed that it is a good source of carbohydrate and it is appropriate to combine it with kilishi, a good source of protein.

Kilishi has moisture content (9.75%). The low moisture content of kilishi compared to that of raw meat could be attributed to the step-wise drying in kilishi processing technique. Drying fresh lean meat to 20% moisture inhibits most bacteria, yeast and moulds, while a level of 15% moisture is needed to inhibit some species of fungi (Ingram and Simonsen, 1980). Water activity is related to moisture reduction in a product, Banwart (1979) reported

that water activity plays a critical role in the fungal spoilage of meat.

The low moisture content of the meal-ready to eat rice showed that the product has been sufficiently dried to minimize microbial growth. Higher fat content of kilishi (18.10%) than raw meat could be due to the residual oil in the defatted groundnut cake used in the preparation. Igene (1988) noted that kilishi is very high in lipid content on dry matter basis (25.23%), this consisting mostly of triglycerides while the level of fat in fresh meat was less than 10.0%.

Jones et al. (2001) reported a fat content as high as  $25.36 \pm 1.35\%$ . Ockeman and Li (1999) reported that the level of lard addition in a dehydrated meat product is the main effect that influences the meat flavor. The type of oil as well as the level of inclusion could also influence flavor positively or negatively.

Ash levels were high in kilishi (7.10%) when compared with fresh meat which usually contains about 1% minerals on wet basis as highlighted by Matz and Beachell (1969). This could have been contributed by the added ingredients. Similar observations were reported by Padmashree et al (1987) on cowpea flour due to adhering dirt on the roasting medium. Also, high ash content of kilishi is indicative of the individual mineral levels of the spices to give a cumulative mineral level minus the loss during processing (Ogunsola and Omojola, 2008). An ash content of  $6.72 \pm 0.13$  was reported for traditionally prepared Kilishi (Jones et al., 2001) while Igene et al. (1990) reported a value of 9.6% for the finished product and 7.83% for the dried infused product prior to roasting. Kilishi supplies a significant proportion of desirable nutrients as far as minerals are concerned. This is contrary to the report of Ogbonnaya and Linus (2009) who reported the processing of beef into kilishi led to a decrease in the availability of minerals: calcium and magnesium.

The results of microbial load obtained were in agreement with the report of (Venia et al., 2006) for dehydrated 'Kilishi' stored for 2 days post production and also were comparable with 3.25 - 7.27 reported by Kembu and Okubanjo (2002) for raw and steam - cooked beef and beef patties before dehydration.

Generally, fungal count decreased from an initial value of  $8 \times 10^2$  CFU/g to  $4 \times 10^2$  and  $3 \times 10^2$  in kilishi stored at 27 and 50°C respectively. Again, fungal counts decreased from  $9 \times 10^2$  CFU/g in ready-to eat rice to  $4 \times 10^2$  and  $2 \times 10^2$  CFU/g at 27 and 50°C, (Table 2) respectively. Reduction in the fungi population during

**Table 2.** Microbial population in CFU/g of kilishi and meal-ready-to eat rice.

Day	Kilishi				RTE rice			
	Temperature @ 27 ± 2°C		Temperature @ 50 ± 2°C		Temperature @ 27 ± 2°C		Temperature @ 50 ± 2°C	
	Fungi Count	Coliform Count	Fungi Count	Coliform Count	Fungi Count	Coliform Count	Fungi Count	Coliform Count
0	8 × 10 <sup>2</sup>	NC	8 × 10 <sup>2</sup>	NC	9 × 10 <sup>2</sup>	NC	9 × 10 <sup>2</sup>	NC
1	6 × 10 <sup>2</sup>	NC	5 × 10 <sup>2</sup>	NC	6 × 10 <sup>2</sup>	NC	4 × 10 <sup>2</sup>	NC
7	5 × 10 <sup>2</sup>	NC	4 × 10 <sup>2</sup>	NC	5 × 10 <sup>2</sup>	NC	3 × 10 <sup>2</sup>	NC
14	4 × 10 <sup>2</sup>	NC	3 × 10 <sup>2</sup>	NC	4 × 10 <sup>2</sup>	NC	2 × 10 <sup>2</sup>	NC

NC = No count at lowest concentration.

storage is attributed to lower moisture content attained by the product during storage at elevated temperature condition, as well as spices used in the production of the samples. This is similar to the result of Okonkwo (1998) on quality attributes of kilishi produced from minced meat. Coliforms were not detected in the products thereby suggesting the absence of food poisoning enteric. Although, Solberg et al. (1976) reported bacteria count exceeding 10<sup>5</sup>/g or coliform count of 10<sup>2</sup>/g in delicatessen food products are indicative of dangerous contamination.

Free fatty acid (FFA) value in kilishi gradually increased with storage time and temperature. However, FFA value did not exceed the 1.2 - 2.1% limit which was reported by Pearson (1968a) to be the minimum limit for odour to be acceptable. FFA level of kilishi during 14 days storage at elevated condition (50°C) was about 1.8%, which implies that kilishi will maintain a good quality at a considerably long period of storage since elevated condition hastens rancidity.

Fat is extremely important in flavor development of meat. As meat ages, the fat deteriorates through microbial attack and tissue enzyme activity which causes the development of free acidity and oxidation of unsaturated fatty acids. This results in the development of bad odours and deterioration of taste. It has been reported by Pearson (1968b) that unpleasant flavours in the cooked beef were first noticed at a level of 2 - 3% (as oleic acid) in extracted fat.

## Conclusion

A ready to eat product from rice and kilishi was developed. Nutritional and microbial evaluation indicated that the RTE rice and kilishi was beneficial and acceptable. FFA levels of kilishi were within acceptable limits indicating good storability. In view of these, the kilishi and Meal-Ready-To-Eat-Rice could be used as a convenience food item.

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