



Kaftas prepared with V-shaped filleting chips of the Nile tilapia (*Oreochromis niloticus*) exposed to smoking techniques

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ABSTRACT. Kaftas with V-shaped filleting chips of the Nile tilapia (*Oreochromis niloticus*) were developed and the effects of the smoking technique on the characteristics of chemical composition, microbiological, sensory and benzo(a)pyrene were investigated. The filleting chips were ground and filleting included condiments and bacon. Kaftas were molded, frozen and distributed in a completely randomized design with three treatments (T 1 = baked in a grid; T 2 = smoked by friction and T 3 = smoked by liquid smoke) with 10 replications. The kaftas subjected to hot smoke had lower moisture content (13.97%), whereas the no-smoking kaftas had the highest content (20.49%). Kaftas with liquid smoke had high crude protein content (48.06%) and ash (9.49%), whereas the ash content was different only from no-smoking kaftas (8.79%). There was no significant difference in sensory parameters, except for flavor; smoked kaftas with liquid smoke were more accepted by the judges and the worst kaftas were no-smoked kaftas. Microbiological analysis showed that kaftas developed were appropriate to feed human beings within the required standards. Chips filleting is an alternative for the development of kaftas and those subjected to liquid smoke were considered the best.

Keywords: V-shaped fillet, filleting waste, hot smoked, liquid smoke.

Kaftas elaboradas com aparas de corte em 'V' do filé de tilápia do Nilo submetidos a técnicas de defumação

RESUMO. Kaftas com aparas (corte em 'V') do filé da tilápia do Nilo (*Oreochromis niloticus*) foram elaboradas e foi avaliado o efeito da técnica de defumação quanto a composição centesimal, microbiologia, benzo(a)pireno e sensorial. As aparas foram moídas e incluídas os condimentos e bacon, para elaborar as kaftas que foram moldadas e congeladas. As kaftas foram distribuídas em delineamento inteiramente casualizado em três tratamentos (Trat 1 = assado em grelha; Trat 2 = defumação a quente e Trat 3 = defumação com fumaça líquida), com dez repetições. As kaftas submetidas à defumação a quente apresentaram menor teor de umidade (13,97%), enquanto as sem defumação o maior teor (20,49%). As kaftas com fumaça líquida apresentaram maior teor de proteína (48,06%) e cinzas (9,49%), sendo que cinzas diferiu apenas das sem defumação (8,79%). Não houve diferença significativa para os parâmetros sensoriais, exceto para sabor, onde as kaftas com fumaça líquida foram mais aceitas pelos provadores e as piores foram as sem defumação. A análise microbiológica mostrou que as kaftas estavam aptas a alimentação humana, estando dentro dos padrões exigidos. As aparas de filetagem é uma alternativa para a elaboração de kaftas e as submetidas à defumação com fumaça líquida foram consideradas as melhores.

Palavras-chave: corte 'V' do filé, resíduos filetagem, defumação a quente, fumaça líquida.

Introduction

Aquaculture is an activity which promotes economical and social benefits for many populations. It is an excellent source of food mainly due to its nutritional qualities. Whereas food demands in the coming years will increase, particularly with respect to protein and to high nutritional and technological rates, the recovery of proteins from fish, from species of low commercial value or from the industrialization sub-

products is a promising alternative in fish (SIMÕES et al., 1998). Moreover, the search for products that meet consumers' needs generated by the cities' hectic life has become increasingly greater, making it necessary to offer a ready or semi-ready product, easy to prepare and time-saving.

Brazil has one of the lowest fish consumption rates in the world. Among other factors, the index is probably due to lack of knowledge of the population

about the importance of fish in the diet (SIMÕES et al., 1998). Considering its nutritional value, fish meat should be consumed from childhood due to its benefits in the diet. Fish has essential minerals, such as calcium, phosphorus, potassium and iron, with good sensory characteristics, taste, low fat and calorie rates.

Due to its hardiness, fast growth and omnivorous characteristics (FRANCO, 2007), the Nile tilapia (*Oreochromis niloticus*) is one of the most promising species for aquaculture. Its meat has a high nutritional value, featuring good taste and texture, and its fillet, sold frozen, provides a good acceptance. These factors increased the number of processing plants and tilapia waste has become a concern. Therefore, it is necessary to provide and develop products and processes that reduce food waste and increase the supply of products on the market. In the case of tilapia, fillet yield is around 30 and the remaining 70%, which include head, carcass, viscera and skin scales, are waste (VIDOTTI; BORINI, 2006).

According to Boscolo et al. (2001), the production of fish waste from slaughterhouses represent between 62.5 and 66.5% of raw material. However, these residues may be processed to reduce environmental impact. One alternative would be the development of co-products to add value to the supply chain. In the process of Nile tilapia filleting, a V-shaped is done to remove the bones that lie on the anterior region near the sideline. This residue is often placed alongside the carcasses in the pulping machine to obtain mechanically deboned meat. The chips may be milled and the kafta prepared.

Kafta is a typical Arab recipe, made from grilled, baked or fried meat. There are many kafta recipes, each with different types of raw materials (meat or fish) mixed with parsley, mint, coriander and a variety of spices. Depending on the country where kafta is served, other spices may give different tastes to the food.

Great care in handling and storage should be taken for the development of fish kafta and due to its highly perishable quality. For instance, grinding reduces particle size and consequently increases the surface area of the raw material, with a greater sensitivity to changes in quality and enzymatic spoilage during storage. Therefore, good manufacturing practices and appropriate methods of storage should be established which are crucial for the products' quality control involving ground raw pieces.

Current research develops chips with kafta (V-shaped) filleting of the Nile tilapia (*Oreochromis*

niloticus) and verifies the effect of the smoking technique (hot and liquid smoke) on the characteristics of chemical composition and its microbiological sensory index.

Material and methods

Preparation and smoking of kaftas

Kaftas were produced by using 1000 g of chips per treatment. The raw material was not allowed to reach total thawing and an internal temperature averaging 0.5°C was maintained. Raw material was thawed in a refrigerator at temperature ranging between 4 and 7°C.

Chips were milled twice with a 4 mm electric disc grinder to obtain a homogeneous base mass without spines found in this region. The basic trimmings which included spices (garlic, pepper Syrian chimichurri, parsley, mint and chives), creamed onions and bacon 10%, were placed in this homogenized mass. After the homogenization of the mass, 60 g balls were made and molded into kafta sticks and frozen. In Treatment 1 the kafta was roasted on grill; in Treatment 2 it was smoked on stainless steel for 60 min. at 60°C; in Treatment 3 the kafta was placed in a dehydrator for 60 min. at 60°C, after passing through a solution of liquid smoke Krakismoke FI 9027 Plus® (6:1) for 30 s.

Rafter timber (8x8x80 cm) pink eucalyptus (*Eucalyptus globulus*) was used for the generation of smoke, with smoke generated by friction out of the smoking chamber and for maintaining of temperature.

Chemical composition analysis

Moisture, crude protein and ash were determined according to AOAC (1997) and ether extract by Soxhlet method (SILVA; QUEIROZ, 2002). Measurements of total phosphorus were made with ammonium phosphomolybdate by UV-VIS spectrophotometry, following Eijssink et al. (1997).

Benzo(a)pyrene (Be(a)p) rate was determined for the samples undergoing curing. The samples were subjected to saponification with methanolic KOH, liquid-liquid extraction with cyclohexane and dimethylformamide-water (9:1, v v⁻¹) and cleaning column chromatography on silica gel and determined by high performance liquid chromatography with fluorescence detection (HPLC). Samples were homogenized, weighed (25 g) and extracted with 200 mL of methanolic KOH (2 mol L⁻¹) under reflux at 80°C for 5 hours. The extract was transferred to a separating funnel and 100 mL solution of methanol: water (9:1, v v⁻¹)

was added. The samples were extracted with 2 portions of 150 mL of cyclohexane and washed with 100 mL of methanol: water (1:1, v v⁻¹). The extract was transferred to a round-bottom flask and dried in a rotary evaporator at 40°C until reaching a volume of about 3 mL. A glass column packed with silica gel (deactivated with 15% water) with 2.5 g of anhydrous sodium sulfate on the top of the column was used for the cleaning of the extracts. The extract was applied to the top of the column and eluted with 85 mL of cyclohexane. The first eluted 10 mL were discarded and the fraction ranging between 10 and 85 mL was collected in a round-bottom flask and concentrated in a rotary evaporator at 40°C to dry. The residue was then suspended in 2 mL of acetonitrile and filtered through a 0.45 µm filter (Millex-HV, Millipore) for subsequent injection into the chromatograph. High performance liquid chromatography with fluorescence detection was the analysis technique. A Shimadzu chromatographic system comprising a pump model LC-20AT, automatic injector SIL-20AT, oven of column CTO-20^a, and detector RF-10A XL was employed. Data were acquired and processed by software LCsolution. A C18 polymer column (Vydac 201 TP54, 4.6x25 cm, particles of 5 µm, stabilized at 30°C) and a mobile phase composed of acetonitrile-water (75:25, v v⁻¹) with flow rate at 1 mL min.⁻¹ and injection volume of 30 µL were employed for the separation of the compounds. Detection occurred at a wavelength of 290 (excitation) and 430 nm (emission). The identity of the compound was confirmed by comparing retention times of sample peaks with standards and co-chromatography.

Sensory analysis

Kafta samples (± 20 g) were wrapped in aluminum foil, identified and offered in plastic dishes to 50 tasters comprising undergraduate students, professors and employees of the Universidade Estadual de Maringá, between 18 and 65 years old. They assessed the aroma, flavor, appearance, texture and color. A form with a 9-point hedonic scale was used featuring extremes 1 (I disliked it very much) and 9 (I liked it very much) (DUTCOSKY, 2011). The project was approved by the Standing Committee for Ethics in Research Involving Humans (COPEP / CAAE 0175-11) of

the State University of Maringá, Maringá, Paraná State, Brazil and all participants signed a consent form to participate in accordance with the standards required by the ethics committee.

Microbiological analyses

Microbiological analyses were performed for the most probable number (MPN) of coliforms at 35 and coliforms at 45°C, counting coagulase positive colony forming units g⁻¹ and for Salmonella spp, according to APHA (2001). Protocol followed the microbiological standards recommended by RDC Resolution N. 12, dated January 2, 2001, by the National Agency of Sanitary Surveillance (BRASIL, 2001).

Statistical analysis

The experimental design was completely randomized with three treatments (T 1 = no smoking; T 2 = hot smoking; T 3 = liquid smoking) and nine repetitions, with the batch of chips (1000 g per batch) as the experimental unit.

Results of the analyzed variables underwent analysis of variance, and means were compared by Tukey's test at 5% probability (SAS, 2001).

Results and discussion

There were significant differences for moisture, crude protein and ash. Non-smoked kafta had the highest moisture content (20.49%), whereas hot smoked kafta had the lowest content (13.97%). Crude protein was higher in kaftas with liquid smoke (48.06%), with no differences between the other treatments. Ash was higher in liquid smoked kaftas (9.49%) which differed only from non-smoked kaftas (8.79%) (Table 1). Souza (2011) reported lower rates than 12.36-12.86% for protein, 4.09-9.41% for fat, and 3.22-3.58% for ash for kaftas *in natura* prepared with the addition of four levels of the swine fat (0, 5, 10 and 15%).

Rates were lower than those obtained in current experiment because kaftas were analyzed fresh, whereas in current experiment the kaftas were grilled or smoked, providing a decrease in moisture content and concentration of other nutrients.

Table 1. Analysis of the chemical composition of kaftas prepared from filleting chips of Nile tilapia subjected to different curing techniques.

Treatment	Moisture (%)	Crude Protein (%)	Ether Extract (%)	Ash (%)	Phosphorus (%)	benzo(a)pyrene (mg Kg ⁻¹)
T 1	20.49 \pm 0.41 ^a	43.34 \pm 0.43 ^b	24.99 \pm 0.93 ^a	8.79 \pm 0.22 ^b	1.40 \pm 0.03	0.02 \pm 0.001
T 2	13.97 \pm 0.31 ^c	43.72 \pm 0.30 ^b	27.41 \pm 0.97 ^a	9.49 \pm 0.18 ^a	2.29 \pm 0.02	0.45 \pm 0.030
T 3	16.98 \pm 0.42 ^b	48.06 \pm 0.57 ^a	23.00 \pm 0.13 ^c	9.30 \pm 0.50 ^{ab}	1.38 \pm 0.02	0.08 \pm 0.007

^aDifferent lowercase letters in the same column indicate significant differences (p < 0.05).

According to Ogawa and Maia (1999), fish muscle may contain 60-85% moisture, approximately 20% protein, 1-2% ash, 0.3-1.0% carbohydrate and 0.6 to 36% lipids. The lipid content variation is a function of the type of body muscle in the same species, sex, age, season, habitat and diet, among other factors. An inverse relationship exists between the well characterized moisture and lipids, as well as between water and protein in smaller amounts.

The dough prepared from kafta produced rates in chemical composition close to those reported by Ogawa and Maia (1999). Fresh kafta revealed 71.5 moisture, 12.86% crude protein, 8.30 fat and 3.22% ash (SOUZA, 2011). High rates of kafta ash were due to the quantity of chips in the spines. After submitting to different treatments, a reduction in moisture and nutrient concentration occurred. The product was prepared in accordance with Regulation Technical Identity and Quality Burger establishing a minimum (15%) to a maximum (23%) of protein and fat, confirming the nutritional advantages of the product (BRASIL, 2000).

Non-smoked kaftas had 1.40% phosphorus; hot smoked kaftas had 2.29% and liquid smoked kafta had 1.38%. Highest phosphorus rate was reported in hot smoked kaftas due to the higher degree of dehydration occurred (Table 1). In fact, the lower the moisture contents in the product, the higher the concentration of nutrients in the product. Analyzing benzo(a)pyrene levels in kaftas, it was reported that the hot smoked kafta exhibited the highest levels of benzo(a)pyrene.

According to Maga (1988), the traditionally hot smoked fish averaged 0.4 mg kg^{-1} and could reach 1.1 mg kg^{-1} . These variations depended on exposure time and the effect of smoke in smoked products. The temperature of smoke generated is a key factor that influences the levels of Polycyclic Aromatic Hydrocarbons (PAHs) in smoke (SIMKO, 1991). However, not only temperature affects the amount of benzo(a)pyrene, but the exposure time of the product to the compounds in the smoke pyrolysis. Further, Azeredo et al. (2006) stated that smoked fish under appropriate conditions normally exhibited a low amount of benzo(a)pyrene, ranging between 0.1 and 0.5 ug Kg^{-1} . The amount of benzo(a)pyrene

should not exceed 1 g Kg^{-1} of meat and smoked fish, which is the maximum rate according to laws in some countries (PRÄNDL et al., 1994). The rates obtained in current study are within the rate range reported by Azeredo et al. (2006). In general, the PAHs measured in this survey (including those known to be more harmful to health) were generally found at low levels. Higher concentrations of PAHs were generally found in traditionally smoked fish. In fact, the Foods Standards Agency (2012) states that there is no need for consumers to change their eating habits.

In the case of sensory analysis, there was only a difference in flavor. Liquid smoked kaftas were more accepted (I liked it very much), whereas non-smoked kaftas had the worst ranking (I liked it only fairly) (Table 2). Although no significant difference occurred in aroma, flavor, appearance, texture and overall acceptance, there was a trend toward higher scores in treatments in which kaftas underwent smoking with liquid smoke. It was necessary to add 10% of bacon to the kaftas to provide a better texture and greater consumer acceptance. In fact, as fat contents increase, the water retention in the product increases: increase in moisture provides more succulence.

Since the tilapia may be considered a lean fish, the addition of bacon raises fat rates; if some fat is not included, the product produced will be very dry, or rather, without any juiciness. The addition of bacon was an asset in the smoking process regardless of the technique. In fact, the fat absorbs smoke compounds whether natural or liquid. The fat content is very important for the smoking process. Fatty fish (over 10% lipids) are the most suitable, mainly due to the fact that the muscle-fat interferes with the aroma and flavor of smoked products (NUNES, 1999). Geromel and Forster (1982) argue that the fat in fish acts as absorber of aromatic substances in the smoke.

The product was generally well accepted by the judges, with special reference to flavor and aroma of kaftas produced with smoking liquid, close to 8 in the hedonic scale. As a rule, smoked kaftas had a better appearance due to staining caused by smoking, with a general acceptance slightly high than 70%. Acceptance rate should be less than 70% for a product to have a good acceptability (DUTCOSKY, 2011).

Table 2. Average of grades of sensory analysis of kaftas prepared from scrap filleting of Nile tilapia subjected to different curing techniques.

Treatment	Aroma	Flavor	Appearance	Texture	Color	Overall Acceptance
T 1	6.7 ± 2.1^a	7.15 ± 1.7^b	6.9 ± 1.9^a	6.87 ± 1.9^a	7.02 ± 1.6^a	7.35 ± 1.64^a
T 2	7.3 ± 1.5^a	7.45 ± 1.4^b	7.35 ± 1.2^a	7.05 ± 1.7^a	7.43 ± 1.4^a	7.43 ± 1.36^a
T 3	7.6 ± 1.7^a	8.0 ± 1.5^a	7.65 ± 1.5^a	7.35 ± 1.9^a	7.55 ± 1.3^a	7.83 ± 1.38^a

^aDifferent lowercase letters in the same column indicate significant differences ($p < 0.05$).

Kafta mass underwent microbiological testing and the results displayed an absence for the *Salmonella* spp; 2.4×10^3 values for most probable number (MPN) of coliforms at 35°C and < 4 for coliforms at 45°C. Positive coagulase CFU g⁻¹ count was $< 1 \times 10^2$.

After subjecting kaftas to hot or liquid smoking process, and to grilling, there was a reduction or elimination of microorganisms. Thus, the product may be prepared as food since it lies within the standards required in accordance with microbiological analysis.

Conclusion

Fillet pieces of the Nile tilapia showed a good potential for producing kafta subjected to the smoking technique. Therefore, chips filleting is an alternative food with high acceptance. Smoked kafta, mainly with liquid smoke, may be an instance of alternative food and an innovatory option on the market.

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