

## FEASIBILITY OF USING MECHANICALLY DEBONED MEAT (MDM) OF NILE TILAPIA TO PRODUCE AN EMULSIFIED TYPE OF SAUSAGE

VIABILIDADE DA UTILIZAÇÃO DA CARNE MECANICAMENTE SEPARADA (CMS) DE TILÁPIA DO NILO NA ELABORAÇÃO DE UM PRODUTO TIPO “MORTADELA”

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### SUMMARY

The objective was to evaluate the addition of wheat fiber and corn oil in the preparation of an emulsified type of sausage made with mechanically deboned meat (MDM) of Nile tilapia and to analyze the bacteriological, physico-chemical and sensory parameters. Four different formulations (F) were prepared: F1 (washed MDM, 0% corn oil and 0% wheat fiber); F2 (washed MDM, 10% corn oil and 2.5% wheat fiber); F3 (washed MDM, 20% corn oil and 5% wheat fiber) and F4 (unwashed MDM, 20% corn oil and 5% wheat fiber). All tested products presented negative results for coagulase positive staphylococci. The washed MDM presented lower counts of mesophilic aerobes. All formulations showed lipid levels lower than those established by law. Formulations F3 and F4 also displayed moisture content lower than the requirement. Protein contents were higher than those required by the Brazilian legislation. Ash content of washed MDM was lower compared to unwashed. Calcium contents were found suitable for MDM. Higher percentage of crude fiber was detected when higher levels of wheat fibers were added to the formulation. The highest pH value was 6.63 for F1. The average Aw was 0.98. Greater firmness was observed in products that contained more fibers. For the sensory variables of appearance, flavor, texture, and global evaluation, formulation F4 was considered significantly better ( $p<0.05$ ) by Tukey test, compared to the other formulations. However, for the color parameter there was no significant difference among samples. Formulation F4 also had the lowest rejection rate by the panelists. Therefore, it is recommended for the preparation of the emulsified type sausage made of Nile tilapia MDM with added corn oil and wheat fiber.

**KEY-WORDS:** Emulsion. Insoluble fiber wheat. Corn oil. *Oreochromis niloticus*. Utilization of waste from filleting.

### RESUMO

Objetivou-se avaliar a adição de fibra de trigo e óleo vegetal de milho na elaboração de um produto emulsionado tipo “mortadela” elaborado com carne mecanicamente separada (CMS) de tilápia do Nilo e analisar os seus parâmetros, bacteriológicos, físico-químicos e sensorial. Foram elaboradas quatro diferentes formulações: F1 (CMS lavada 0% de óleo de milho e 0% de fibra de trigo), F2 (CMS lavada 10% de óleo de milho e 2,5% de fibra de trigo) F3 (CMS lavada, 20% de óleo de milho e 5% de fibra de trigo), formulação F4 (CMS não lavada, 20% de óleo de milho e 5% de fibra de trigo). Todos os produtos apresentaram resultados negativos para estafilococos coagulase positiva. A CMS lavada apresentou contagens inferiores de microrganismos aeróbios mesófilos, quando comparada a CMS não lavada. As formulações F3 e F4 apresentaram teor de umidade inferior à legislação enquanto todas formulações apresentaram teores de lipídeos inferiores aos estabelecidos. Os teores de proteínas das CMS foram superiores aos preconizados por essa legislação. As cinzas das CMS lavadas foram inferiores a CMS não lavada. Os teores de cálcio foram considerados dentro do previsto para as CMS. Maior percentual de fibra bruta foi detectada nas formulações onde foram adicionados maiores teores de fibra de trigo. O maior valor de pH foi de  $6,63\pm0,1$  na F1. A atividade de água média foi de 0,98. Maior firmeza foi observada nos produtos com maior percentual de fibra. A F4 foi superior as demais apresentando diferenças significativas ( $P<0,05$ ) pelo teste de Tukey, exceto para o atributo cor que não houve diferença significativa e obteve o menor índice de rejeição. A F4, é recomendada entre as demais para a elaboração da mortadela de CMS de tilápia do Nilo adicionada de óleo de milho e fibra de trigo.

**PALAVRAS-CHAVE:** Aproveitamento dos resíduos da filetagem. Emulsão. Fibra de trigo insolúvel. Óleo de milho. *Oreochromis niloticus*.

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## INTRODUCTION

Tilapia is the second largest group among the species produced in Aquaculture (NAYLOR et al., 2000), and represents between 40 and 50% of the Brazilian farmed fish (KUBTIZA, 2003).

During processing, approximately 65% of live weight is discarded after filleting. The leftover meat on the carcass is called mechanically deboned meat (MDM) (SIDDAIAH et al., 2001) (OGAWA, 1999). MDM is defined as the frozen product obtained from headless fish, eviscerated, clean and mechanically separated from the muscles and body structures, followed by the name of the species that characterizes the meat (BRASIL, 2008). The proposal to regulate fish MDM has been included and submitted to Regulamento de Inspeção Industrial e Sanitária de Produtos de Origem Animal (RIISPOA).

MDM processing should follow strict procedures to avoid risks to human health (MORI et al., 2006). The physical, microbiological and sensory parameters may be changed when the percentage of MDM is increased (DAROS et al., 2005). However, Kirschnik (2007) while studying tilapia MDM stability, observed that the meat remained stable and good for consumption, independent of the presence of additives.

Research studies have shown the beneficial effect of fibers to prevent and treat colon diseases, to reduce colon cancer and to control diabetes *mellitus* (MATTOS & MARTINS, 2000).

Also, when fibers are added to meat products, they increase cooking yield and water holding capacity (WHC), decrease production cost and improve food texture (DIPENMAAT-WOLTERS, 1993).

The development of meat products with lower fat content has been under great demand due to increasing awareness of the consumer regarding healthy diets with low calorie content. A product may be considered low calorie when there is 25% less calories compared to the original (BRASIL, 1998).

Therefore, the objective of the work is to use tilapia MDM as a raw material to produce an emulsified type sausage with added insoluble wheat fiber and corn oil, and to determine their effect on the quality parameters of the final product.

## MATERIAL AND METHODS

The emulsified type of sausage was produced at Núcleo de Processamento de Alimentos (NUPPA) da Universidade Federal da Paraíba (UFPB), Paraíba, Brazil. The MDM was supplied as a 2kg-frozen-blocks by a company from Recife, PE, Brazil. Four different formulations were prepared, each containing 3kg of MDM: F1 (0% corn oil and 0% wheat fiber); F2 (10% corn oil and 2.5% wheat fiber); F3 (20% corn oil and 5% wheat fiber) and F4 (20% corn oil and 5% wheat fiber). In treatments F1, F2 and F3 the raw material (MDM) was previously washed, while in F4 (formulated as F3) the MDM was not washed. The other ingredients used were the same in all four treatments: salt (2%), curing salt (0.25%), antioxidant

(0.25%), poly-phosphate (0.3%), sugar (0.2%), cassava starch (3.5%), soybean protein (1%) and spices (pepper, onion, basil, garlic, bay leaves, walnuts, ginger and mustard) (0.68%). Mass preparation was done using a cutter table (Jamar, model K-10), while keeping MDM at a temperature between -2 and 0°C by adding ice. After the emulsification, the meat mass was stuffed into polyamide plastic casings according to Moreira (2005). For each kg of MDM, final product yield was: 1200g for F1, 1325g for F2, and 1450g for F3 and F4 as well.

Immediately after production, sausages and raw material used in the process were taken to Laboratório de Inspeção de Carne e Leite (LICAL) da Universidade Federal Rural de Pernambuco (UFRPE) to perform the following bacteriological analysis: coagulase positive staphylococci (BRASIL, 2003), mesophilic aerobes count according to Silva et al. (2001), analysis of water holding capacity (WHC) following the method described by Hamm (1960) and pH, using a pHmeter Analion, model pm 608.

The physico-chemical parameters were analyzed at Laboratório de Experimentação e Análise de Alimentos (LEAAL) da Universidade Federal de Pernambuco (UFPE). All MDM and sausages analysis were replicate three times. Proximate composition, calcium and crude fiber contents were determined following the methodology cited in Adolfo Lutz (2005) and carbohydrates were calculated (ASCAR, 1985).

The color analysis was performed at Departamento de Ciências Domésticas da UFRPE, using a Minolta Color Reader CR-400 colorimeter with reflectance mode, using diffuse light, illuminant C (type of light source that represents the average light of the day, color temperature of 6740°K) and the angles 0° and 2°, relative to detection and observer angles, respectively, operating in the CIE system ( $L^*$ ,  $a^*$  and  $b^*$ ), where  $L^*$  is luminosity,  $a^*$  redness and  $b^*$  yellowness. The measurements were taken at three different points of the emulsified product, and the mean values were recorded according to methodology reported by (ABULARACH et al., 1998).

Analysis of water activity was performed using an Aqualab CX-2, Decagon Devices. Analysis of texture profile was replicated three times, at a temperature of 21°C, using a texture meter TA-xT2i (Stable Micro Systems). To assess firmness, the sausages were sliced into 10mm-slices and further compressed to 5mm. This analysis used an aluminum probe (SMS P/20), with pre-test, test and post-test speed of 1mm/s away 20mm from the platform (BOURNE, 1978).

The sausages were then submitted to sensory analysis to determine the acceptance of the product according to Stone & Sidel (1993) at Departamento de Ciência Doméstica, UFRPE, by 51 untrained panelists in the age bracket between 18 and 55 years old, 37 females and 14 males, selected for consuming sausage and fish. The samples were served simultaneously, at room temperature. The slices were placed in disposable plates, numbered randomly by a three digit-number, and served unsalted crackers and a glass of water at room temperature (used to remove residual flavor).

Each panelist was given an evaluation card to be filled. The parameters appearance, color, odor, flavor, texture and global evaluation that determine product acceptance were measured by a hedonic scale varying from 1= "did not like very much" to 9="like very much". The intent to purchase was tested in a scale from 1="possibly not buy" to 5= "buy". The data were submitted to variance analysis and means were compared by Tukey test ( $p<0.05$ ). The sensory analysis involving the panelists was evaluated and approved by the Ethics Committee of Universidade de Pernambuco (UPE), under registration number CEP/UPE 147/10. The study was conducted as determined by Resolution 196/96 of Conselho Nacional de Saúde.

## RESULTS AND DISCUSSION

The emulsified type of sausage and MDM used were negative for coagulase positive staphylococci (Table 1). These results were in agreement with the results found for sausage made with tilapia MDM by Oliveira Filho et al. (2010). At the present, there is no specific legislation to regulate fish sausage, the only available regulation establishes  $3 \times 10^3$  UFC/g as the

limit of staphylococci in beef sausage (BRASIL, 2000).

Washed MDM displayed lower counts of mesophilic aerobes compared to unwashed MDM. Similar behavior was observed for the sausages, which may be explained by lower contamination of the raw material used. According to Alcantara (2002) the washing process promotes bacteria removal. Although they are used as an indicator, mesophilic bacteria are not addressed by the legislation RDC 12 (BRASIL, 2001). However, the results are within the limits established by the legislation of Sao Paulo state (BRASIL, 1978)  $3.0 \times 10^6$  UFC/g of food.

The physico-chemical analysis results (Table 2) show that as oil content in the formulation increased, moisture decreased. These results are in agreement with the results reported by Moreira (2005), when studying moisture content of emulsified sausage made from tilapia fillet with added vegetable fat. Only F3 and F4 were within the standards established for beef sausage that limits moisture at 65%. However, fat levels were below the limit of 30% established by the legislation (BRASIL, 2000).

**Table 1 - Bacteriological analysis of MDM and the emulsified type of sausage.**

Analysis	Coagulase positive staphylococci counts UFC/g	Mesophilic aerobes counts UFC/g
Washed MDM	Negative	$4.3 \times 10^2$
MDM 2	Negative	$6.6 \times 10^5$
Sausages		
F1	Negative	$1.2 \times 10^2$ (est)
F2	Negative	$4.0 \times 10^2$
F3	Negative	10
F4	Negative	$5.3 \times 10^4$ (est)

MDM: Mechanically deboned meat; F1: (washed MDM, 0% corn oil, 0% wheat fiber); F2: (washed MDM, 10% corn oil, 2.5% wheat fiber); F3: (washed MDM, 20% corn oil, 5% wheat fiber); F4: (unwashed MDM, 20% corn oil, 5% wheat fiber). Est: estimate.

**Table 2** - Physico-chemical composition of the MDM and sausages

Samples	Moisture	Proteins (g/100g)	Ashes (g/100g)	Carbohydrate (g/100g)	Lipids (g/100g)	Calcium (mg/100g)	Crude Fiber (g/100g)	pH
Washed MDM	76.34 ± 0.3	14.29 ± 0.2	0.45 ± 0.1	0.00	9.26 ± 0.3	18.18 ± 0.4	0.38 ± 0.5	6.34 ± 0.0
Unwashed MDM	72.75 ± 1.3	13.02 ± 0.3	1.08 ± 0.3	2.09 ± 1.2	11.03 ± 0.5	23.58 ± 11.4	1.43 ± 0.6	6.29 ± 0.1
<b>Sausages</b>								
F1	75.90	11.72	2.46	4.02	5.90	19.60	0.49	6.63 ± 0.1
F2	69.62	9.14	2.05	6.35	12.84	21.97	2.05	6.24 ± 0.0
F3	64.19	8.91	2.05	4.58	20.30	25.72	3.31	6.28 ± 0.2
F4	59.38	11.46	2.29	5.63	21.24	39.76	2.23	6.41 ± 0.0
>Δ	15.51	2.81	0.41	2.33	15.34	20.16	2.82	0.39

MDM: Mechanically deboned meat; F1: (washed MDM, 0% corn oil, 0% wheat fiber); F2: (washed MDM, 10% corn oil, 2.5% wheat fiber); F3: (washed MDM, 20% corn oil, 5% wheat fiber); F4: (unwashed MDM, 20% corn oil, 5% wheat fiber). >Δ: larger difference.

**Table 3** - Analysis of water activity, color, water holding capacity and texture of the sausages

Sample	Water activity (Wa)	Color			WHC (%)	Texture Firmness ( N)
		L*	a*	b*		
“Sausages”						
F1	0.985	66.39	2.91	7.58	54.00	0.195
F2	0.983	70.41	5.05	8.46	59.00	0.208
F3	0.984	74.57	4.19	9.43	60.00	0.140
F4	0.981	79.47	3.36	10.53	67.00	2.797
>Δ	0.004	13.08	2.14	2.95	13.00	2.657

L\*: luminosity; a\*: redness; b\*: yellowness; MDM: Mechanically deboned meat; F1: (washed MDM, 0% corn oil, 0% wheat fiber); F2: (washed MDM, 10% corn oil, 2.5% wheat fiber); F3: (washed MDM, 20% corn oil, 5% wheat fiber); F4: (unwashed MDM, 20% corn oil, 5% wheat fiber). WHC water holding capacity. >Δ: largest difference among formulations.

Protein levels of washed MDM were higher compared to MDM unwashed. These results differed from the results reported by Kirschnik & Macedo-Viegas (2009) while studying tilapia washed MDM, by ADU et al. (2003) and Gryschek et al. (2003) that reported considerable loss of protein and other hydrosoluble compounds after washing MDM from tilapia and several rockfish species (*Sebastes* sp.). Protein levels of the sausages were lower than the 12% minimum required for beef sausage (BRASIL, 2000).

Washed MDM had lower ash level, result similar to those reported by Kirschnik & Macedo-Viegas (2009) and Gryschek et al. (2003). This decreasing ash content may be attributed to minerals being leached during washing. Similarly, MDM calcium levels were lower than the standards required by the legislation (BRASIL, 2000). The determination of calcium content in MDM is a way to control the yields obtained during mechanical separation processes, where higher bone content requires higher deboning pressure (BERAQUET, 2000).

Crude fiber contents were high for unwashed MDM, as well as in the formulations where insoluble wheat fiber was added. All products may be labeled as “contain fibers”, while F3 may be considered as “source of fibers” according to legislation (BRASIL, 1998).

The addition of polyphosphate to the products explain pH results, these data are corroborated by Konno (1992).

Analysis of other physico-chemical parameters show that water activity (Table 3) remained constant for all treatments (0.98). The product is classified as food with high water activity, which favors microorganisms proliferation according to Jay (2005), and therefore, it needs to be stored refrigerated.

Physical parameters such as color, varied in absolute terms with respect to total difference: 66,88 (F1); 71,09 (F2); 75,28 (F3); 80,23 (F4). The results agreed with the sensory analysis where the light color of F4 displayed the higher rejection rate by the panelists. These results were similar to those reported

by Uyhara et al. (2008) that observed higher color acceptance when cochineal and annatto were added to sausage produced from Nile tilapia MDM.

In the present study F4 displayed the highest WHC, a result that corroborate Garcia et al. (2002) who consider that water holding capacity can be increased by using insoluble fibers.

Higher firmness was observed when more wheat fiber was added, and it was associated with unwashed raw material. These results were in agreement with those reported by Barreto (2007) while researching the addition of fibers to sausages. A firm texture is highly important to the consumer according to Huidobro et al. (2005) and Mendoza et al. (2001).

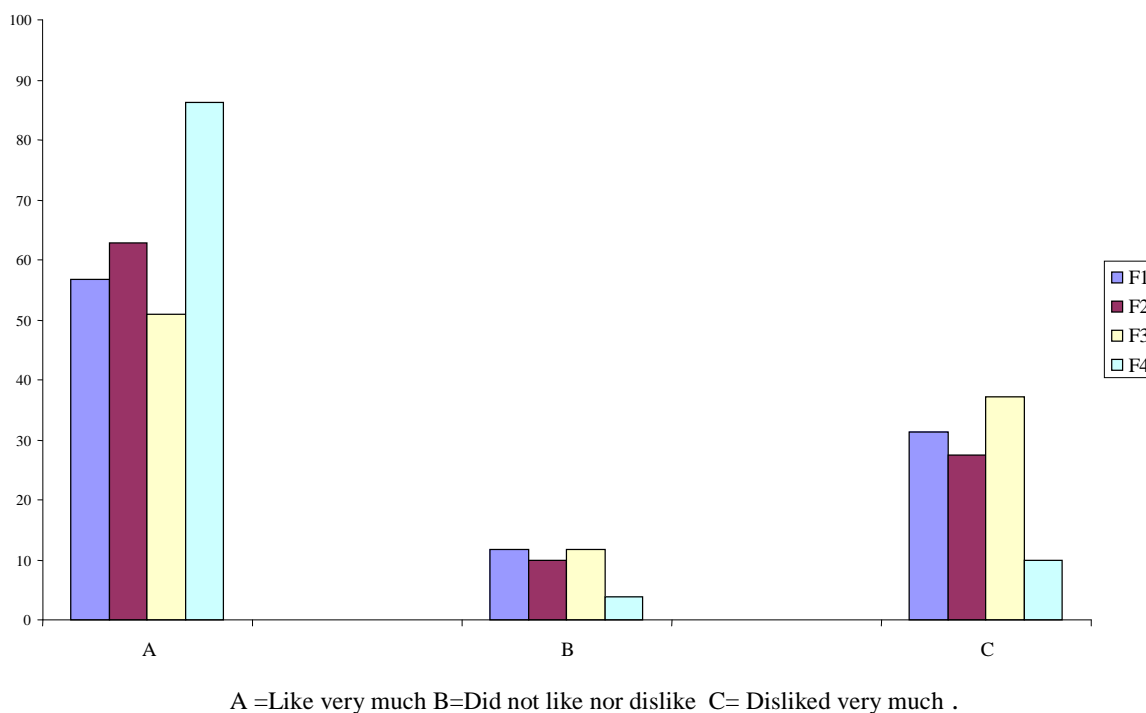
In the acceptance test (Figure 1), F4 received from the panelists “like very much” and “like moderately” for all attributes and 78.43% said that they would buy it and possibly would buy it (Figure 2), except for the color, where the preference was for F3 treatment. The formulation F4 prepared with unwashed MDM was

superior to others, and significantly different ( $P<0.05$ ) by Tukey test for the variables appearance, flavor, aroma, texture and global evaluation. However, color was not significantly different among samples and F4 also had the lowest rejection level. These results are in agreement with those reported by Moreira (2005) to sensory analysis of sausage made with tilapia fillet.

High rejection rate was observed for buying intention of formulations F1, F2 and F3, all prepared with washed MDM. On the other hand, 78.43% said that they certainly or probably would buy F4 prepared with unwashed MDM.

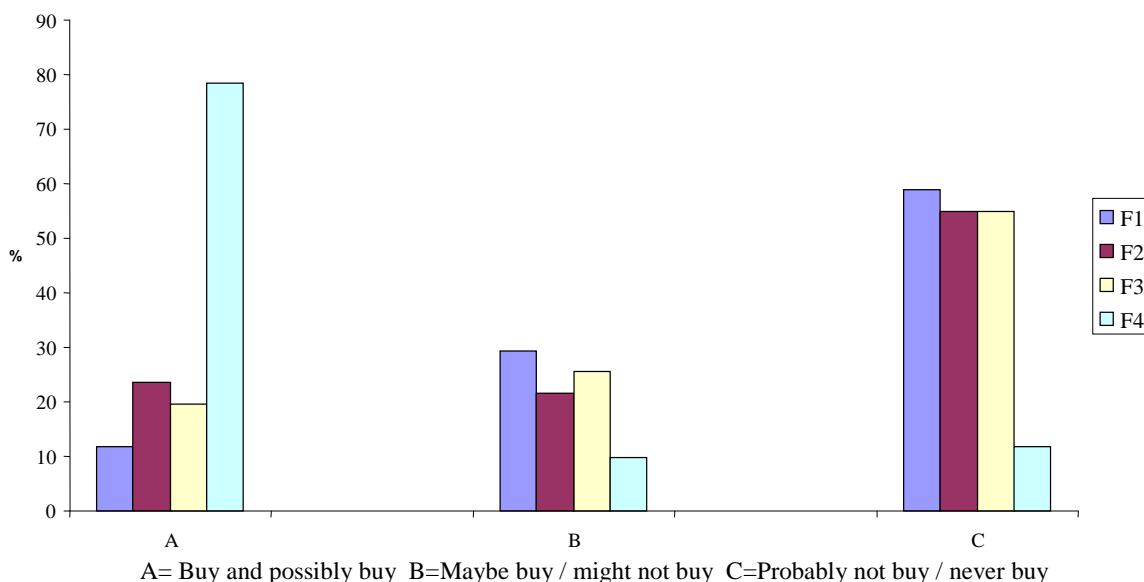
It is feasible to produce an emulsified type of sausage, with high acceptance level, using unwashed MDM of tilapia added corn oil and wheat fiber.

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**Figure 1** - Acceptance test results with respect to global evaluation for the sausages.

F1: (washed MDM, 0% corn oil, 0% wheat fiber); F2: (washed MDM, 10% corn oil, 2.5% wheat fiber); F3: (washed MDM, 20% corn oil, 5% wheat fiber); F4: (unwashed MDM, 20% corn oil, 5% wheat fiber).



**Figure 2** - Intention of buying the emulsified type of sausage.

F1: (washed MDM, 0% corn oil, 0% wheat fiber); F2: (washed MDM, 10% corn oil, 2.5% wheat fiber); F3: (washed MDM, 20% corn oil, 5% wheat fiber); F4: (unwashed MDM, 20% corn oil, 5% wheat fiber).

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