Water Buffalo (Bubalus bubalis) and their Technological Advantages for the Design in Healthy Meat Product

J.F. Rey* and I.E. Povea

Salle University, Bogota, Carrera 2 No 10-70 Piso 7 Bloque D, Colombia

Abstract: Current trends in the formulation for new food shows that healthy or "functional" products are gradually increasing their participation in the preference of the consumers (Catalá Ramón). Nowadays, the participation of meat products in this behavior of the marketing is not growing at the same rate, because their ingredients and nutritional compounds, like saturated fats, which are rejected by consumers. But, a group of investigators from La Salle University (Universidad De La Salle, Bogotá, Colombia), have been working hard, in order to obtain healthier meat products, using Bufalo as the main raw material, because its important properties like 15 to 35% of protein, 40% more water holding capacity (CRA, in Spanish) and 30% more emulsifying capacity (CE in Spanish). Previous values are compared with raw beef. The group, who has developed a functional buffalo meat product, added vegetal oil from soybeans and dehydrated hemoglobin to its formulation and obtained a food with 70% less of saturated fat and a significantly increase of iron, without affecting the non-saturated fat compound of the food. Now, a functional product packed in a "smart packaging" has been studied, in order to increase its shelf life, supported on positive migration process.

Keywords: Buffalo, Meat Products, Healthy products, La salle University.

INTRODUCTION

Asia is considered the Land of the origin of Buffaloes, which was domesticated between 4700 and 4500 b.c. by Africans and European inhabitants who were reponsible for its worldwide presence. For years, tamers have used its milk and meat as their main nutritional source, also they have provided support to the development to the wordwide agriculture.

The interests in the production of buffalo have been risen, due to the high quality of their products and their adaptability to the evironmental conditions [1].

Cholesterol's level of buffalo meat are low, as saturated and trans fats and there is a trend to produce more buffalo´s meat products, as is showed in an Argentinean investigation, which some nutritional advantages of buffalo meat were demonstrated, after a detailed study of some samples of them. Table **1** shows a comparison between buffalo meat and beef meat in chemical compounds y energetically value of fresh meat.

Buffalo meat has great advantages over the beef, which is the most used in processed meat, because its higher proportion muscle/carcass weight, more protein and minerals and lower content of fat, either for direct consumption or for processing in the production of meat products [2]. Today the buffalo sacrifice meets the same requirements for the slaughter of cattle, with the same facilities, equipment and tools necessary for this work [3].

INVESTIGATIONS CONDUCTED IN LA SALLE UNIVERSITY

Currently, the group of investigation "Science, Technology and Engineering in Food Processing", attach to the Food Engineering Program at La Salle University of Bogotá, Colombia, has been developing, since 5 years ago, different investigations which used of buffalo meat for the production of meats products are highlighted.

Some of group´s investigations are:

Evaluation of the Substitution of Animal Fat by Vegetable Fat in the Manufacture of a Heat Processed Buffalo (Bubalus bubalis) Meat Sausage

This study evaluated the substitution of animal fat by vegetable fat in a heat processed meat sausage, made of buffalo meat. The meat sausage developed was "salchichón", a product widely accepted by consumers. Experimental formulations of meat sausage were prepared in triplicate with soybean, sunflower and canola oils at 5, 10 and 15% levels. These formulations were compared with a standard formulation of meat sausage with animal fat. Moisture, protein, fat and texture (Warner-Bratzler) were determined in duplicate. Acceptability was evaluated by an untrained sensory panel. The experimental results were subjected to univariate and multivariate analyses of variance. The formulations with canola oil were discarded because emulsification was not reached.

*Address corresponding to this author at the Salle University. Bogotá, Colombia, Carrera 2 No 10-70 piso 7 bloque D; Tel: 73316258;
E-mail: jrey@unisalle.edu.co

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Table 1: Comparative Analysis Between Buffalo Meat and Cow Meat (100 g of Food)

TYPE OF MEAT	ENERGY Kcal	WATER g	PROTEIN g	FAT g	MINERALS g	CARBOHIDRATES g
Búffalo	101	74,26	23,43	0,52	1,06	0,52
Beef	149	70,5	20,43	7,5	1,15	0,42

Source: Rey y Gualdrón.

The results of the sensory evaluation showed significant differences in favor of the formulations with soybean and sunflower oils when compared with the standard formulation. No significant differences were found between the formulations with soybean and sunflower oils. The formulation with 10% soybean oil had the highest ranking.

Comparative Study of the Physicochemical Characteristics of an Economic Buffalo (Bubalus bubalis) Meat Product and an Economic Beef (Bos Indicus) Meat Product with Incorporation of Bovine Hemoglobin in Powder in Both Formulations

The low dietary intake of bioavailable iron is the major cause of iron deficiency; nowadays, researches are being made to develop iron supplements. The objective in the diet is to increase iron intake through food fortification and dietary diversification as strategies to prevent deficiency of this mineral [4]. Since a few years ago, it has been suggested that hemoglobin in powder is used as a supplementation with iron, also it has shown that, given the structure of it, constitutes an iron shield against absorption inhibitors and foments iron to arrive intact to wall of cells where it is absorbed, apparently the absorption is better when Iron is bound to hemoglobin than the heme-iron without globin [5].

Several studies have shown the higher proportion of iron in buffalo meat, in comparison with other species, its high protein content and low fat values becoming a raw material with great potential for industry [2], for this study, both Buffalo and beef, were characterized physico-chemically, revalidating the information obtained in other researches.

The purpose of the addition of bovine hemoglobin in economic sausages made from Buffalo and one from beef, was measuring the influence of this addition on the physicochemical characteristics and the final Iron content on both products.

The formulation of sausages was following the procedures of meat emulsions [6].

Three sausages were made with meat Buffalo (B), 200 mg / kg of hemoglobin (range selected from [7], and three beef (R) with same level of hemoglobin.

To evaluate the physicochemical characteristics were measured: Total ash (NTC 1668), Humidity (NTC 1663), protein (NTC 1556), fat (NTC 1662) and iron (AOAC 944.02). The statistical analysis was performed with ANOVA ($P < 0.05$), then were compared with Tukey ($P<0.05$) and the difference between samples with bilateral Dunnet test (ICS 95%).

Statistical treatment showed non significant differences for fat (%) (R=14.2352 and B=9.7446), moisture (%) (R = B = 64.9434 and 65.3612), protein (%) (R=13.5347 and B=14.0219) and pH (B=7.01 and R=6.71) values. Difference was significant in ash (%) (R = 1.7572 and B=2.8013) and iron (B=2.82 mg / kg and R =2.52 mg / kg) values, Iron data exceed the minimum recommendations for Iron in Colombia (1184 mg / kg, [8]) and food in Latin-America (1.1 mg/kg, [9]).

Buffalo product presents a better physicochemical and healthy characteristics respect to beef product, especially in terms of protein, fat and iron values compared to the FAO and ICBF values. The result was an economic meat product with hemoglobin according to the 1325 NTC.

Evaluation of Sensory Characteristics and Texture of an Economic Buffalo Meat (Bubalus bubalis) Sausage and an Economic Beef (Bos indicus) Sausage with Addition of Bovine Hemoglobin in Powder

Iron deficiency is one of the 10 preventable disease risks; in Colombia are attributed 800000 deaths per year. As a report of the National Health Institute, anemia is a common disease in children under 5 years (23% of population) (Guerrero, [5]).

Currently, the highest consume of iron comes from vegetables and ferrous salts in food and also consume of heme iron is low, it comes from animal sources, and its found in hemoglobin structure [4]. Iron is an integral

part of hemoglobin, chemical configuration of iron is the main factor of bioavailability. In nature it is found in two forms: nonheme and heme, the last, has a better bioavailability than the first one [10].

The purpose adding bovine hemoglobin in an economic meat product (sausages) made from Buffalo and one from beef, was measuring influence of it on the sensory and texture characteristics of the final product. Three types of sausages were made with buffalo's meat and 100 mg/kg (B1), 150 mg/kg (B2) and 200 mg/kg (B3) of hemoglobin and three with beef (R1, R2 and R3) and the same levels of hemoglobin.

A sensory descriptive analysis test was developed with the rank of five scales, it was evaluated by the statistical test of Kruskal-Wallis and Dunnett which determines final acceptance by consumers, according color, flavor and bite. The sample R3 with 45% of preference, showed a color highest acceptance; for buffalo, B1 was the highest color acceptance with 35% of preference. The samples with greater acceptance in taste were R2 with 45% of preference and B3 with 35% of acceptance. R3, with 30%, and B3 treatment with 50%, were the samples with bite highest preference.

Texture was evaluated by Volodkevich bite test. Statistical analysis was performed with ANOVA and the difference between samples with bilateral Dunnet test (95% ICS. It showed that there is a non significant difference between samples, and also that hemoglobin does not affect the texture of the samples made with buffalo meat (on average, a hardness of 22.89N, and bovine samples obtained a hardness of 19.63 N), indicating that sausages made of buffalo meat have the highest hardness because its muscular tissue as a raw material. The study of iron contents showed that the samples with 200ppmof both products were significantly higher values than those found as minimal by the ICBF, and the FAO.

The highest acceptance was focused on sensory 200ppm treatments for both cases. Also, texture analysis indicated non significant differences in the samples.

The Effect of the Addition of Vegetable Oils in the Mass and Energy Efficiency of Meat Derived Product, Low in Saturated Fat from Buffalo Meat (Bubalus Bubalus)

Today human beings are more likely to develop cardiovascular disease, a cause is by the consumption of saturated fats, which descend good cholesterol (HDL) cholesterol and raise bad cholesterol (LDL) [11]. The food industry has been designing products with unsaturated fats and is now processing turkey with sunflower oil, sausages with soybean oil and hams enriched with omega 3, which result in a new consumer culture [12].

The buffalo meat is important in this trend, because of its nature, of low fat (± 1%) and high in protein (± 23%), making it nutritionally and technologically appreciated by consumers and industry [2]. Colombia has begun to be an alternative for those seeking healthy foods.

For the development of sausage, selected for their high consumption in the country, working with buffalo meat and soybean oil 5% (F1), 10% (F2) and 15% (F3), for a total of three formulations, seeking the best performance in mass and in energy. Get the mass yield and the energy consumption in each of the formulations, is an essential part of the investigation.

After standardizing the design and the process of development, we proceeded to determine the mass balance of the product. It was taken 2 kg as the base for calculation. The best overall performance and efficiency was shown in F2. The overall balance shows that although the efficiency is relatively small each individually formulation has a good performance and efficiency, including the Shaper with losses ranging between 16 and 18%. The drying and blanching have similar yields. F2 is found to have the better results.\

To establish the energy requirements of the product the principle of conservation of energy was applied, considering that the process is a solid phase intermittent the equation would be $Q = m.\Delta H = m.Cp.\Delta T$.

To calculate energy inputs or outputs of the process Cp is calculated for an average humidity of 61%, resulting in an average value of Cp = 3.2075 kJ / kg * ° C, the energy lost in the formulations is 27.96 KJ ± 1.01, which on average is 7%, the results show that the processes is not significantly different, since energy needs are similar and the losses range are very close values.

The sausage cooking takes time, which can be optimized by applying mathematical equations of heat transfer. The determination of this time is important to avoid over-cooking that affects the quality of the product in the hardness and taste.

To optimize the cooking time is used the thermal physical properties of water to calculate dimensionless numbers, the properties of water and factors referred to in the physical and thermal properties, we calculated the numbers Gr, Nu, and the value h. The sausage was shaped in fibrous casings of dimensions as follows: length 30 cm and diameter 6.5 cm. After developing the transient equations for determining the optimal blanching time, the new time of 71 minutes was comparable value with the experimental time of 70 minutes.

Standardization of Maturation Conditions the Buffalo Meat (Bubalus bubalis) in a Second and Third Cuts Quality to Laboratory Level

This research examined the appropriate time and the temperature to improve the buffalo meat Quality in maturation process. Cuts were selected for research the neck (cogote), like second cut and the Shank (lizard) the third cut, being cuts very accepted cuts in Colombia, the pH characteristics, water holding capacity (WHC) for dripping, hardness for Warner Blazter and sensory test were evaluated, the preliminary results prove a low pH, after 21 days of ripening, accelerating the damage of the meat and for this reason this time was the maximum time accepted for research. Different treatments according to temperature (1,2,3y 4 °C) were studied in each cut, It was determined that the cuts exposed to 2 °C developed an acceptable tenderness, and didn´t show degradations after the process compared to the other samples, this was demonstrated in the sensory and textural analysis result. After that three different treatments were applied to each cuts (unpackaged, packaging and vacuum packaging), the vacuum packaging showed the best behavior and acceptance for panelists in comparison with the other cuts, there are significant differences between tenderness, water WHC and two treatments (unpackaged and vacuum packaging), this indicated that ripening process improves the tenderness, it was determinate that iron in each cuts the vacuum packaged and that the mineral content obtained increase 0,11mgFe/100g between 8 and 21 days ripening.

Food Packaging Science and its impact in Buffalo meat Shelf Life

This research shows how important the packaging structure for the shelf life of buffalo is. On one hand, Indices of failure (IoF) like Organoleptic Qualities and Microbial Spoilage were determined in order to account with objective variables to analyze, and, on the other hand, two different types of packaging structures were chose for the study. Additionally, Buffalo meat was packed in direct contact with a natural preservative. The Design of Experiments was supported in previous variables and as IoF change of color was taken, using a Minolta colorimeter, odor and flavor were evaluated by Sensory Panel and tenderness was measured, using a calibrated tenderizer. Packaging structures were labeled as “Structure A” and “Structure B” and both samples of meat were studied under Gram positive and Gram negative bacteria spoilage. In conclusion, a multiple layer packaging structure in direct contact with natural preservative, was chosen by Sensory Panel as the best material to protect Buffalo meat and its shelf life was determined by 14 days under refrigerated conditions.

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