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Research Article

The Effects of Thermal Treatment on the Emulsion Quality of Mutton Meat (*Ovis aries*) and Bovine Meat (*Bos indicus*)

Pedro Romero, Gilma Paadilla and Armando Alvis
Facultad de Ingenierías, Universidad de Córdoba, Programa de Ingeniería de Alimentos,
Carrera 6 N°76-103, Montería, 230001, Colombia

Abstract: The objective of this research was to evaluate the effect of heat treatment in a meat emulsion using mutton and beef. Being animals from the same species, even when they differ on the age of sacrifice, mutton is not as appreciated as lamb for direct consumption, which is why mutton is mostly used for industrial transformation. The purpose of this essay was to determine the effect of scalding over the physico-chemical, texture and sensory quality in a meat emulsion elaborated from mutton meat (Ovis aries) and bovine meat (Bos indicus). Proximal analysis were run on the meat (humidity, protein and fat, the functionals (pH, CRA y CE); meat emulsions were elaborated with variations on the mutton-bovine relation, stuffed and scalded at 70, 72, 74 y 76°C and vacuum packed. The samples were subject to TPA analysis, sensorial and of color. The results of the proximal composition were 16,95% humidity; 18,95% protein; 2,86% fat and regarding the functionalities, of 5,28 for pH, 62,98% for CRA and 38,00% for CE; the results of the texture profile (TPA), showed that for all of the parameters there were significant differences ($p<0.05$) between the temperature and formulation variables. The color analysis show that luminosity, expressed as L* is obtained when emulsion is subject to 76°C or a minimum of 70°C, the sensorial test showed that the most successful sample was the sausage made 100% from mutton meat. It is concluded that with proper scalding temperature and formulation it is possible the industrialization of this type of meat.

Keywords: Color, emulsion, proximal composition, scalding, texture profile analysis

INTRODUCTION

The ram is known in the colombian coast as "camuro", of the *Ovis aries* species and like the bovine, is a ruminant (Bianchi *et al*., 2006a). In Colombia, the yearly consumption per capita is high, compared to other countries; sheep and goat is of 0.31 kg, which compare the participation of this kind of meat to others with 16 to 17 kg (FAOSTAT, 2008). On the other hand, the statistics reflect that the main animal protein sources for human consumption in the order of production for the country is bovine with 46% participation, poultry with 43%, pork with 7%, pisciculture with 2.5% and sheep and goat with 0.4%, therefore stating the low consumption of this type of meat in Colombia. This kind of behaviour is tightly linked to cultural and social traditions therefore labeling the consumption as temporary and depending on the region as well (Restrepo, 2010).

In Cordoba, a department of the country, the production, commercialization and consumption of mutton meat is not technified, which is the reason why it is necessary for the regional associations to promote said agricultural activity (ASOCARNEROS, 2005)

Another factor adding up to the problem previously exposed-and highly influential regarding the lack of popularity of Mutton meat in Colombia-is the little amount of information, or investigation at all of the matter. Right now, out of the 254 investigation projects of the Agricultural and Livestock Technological Colombian Corporation (5), only two of these are related to ovines (Carballo *et al*., 1996).

That being said, it is very important to create and spread knowledge by investigating on the matter. The purpose of this essay was to determine the effect of scalding over the physico-chemical, texture and sensory quality in a meat emulsion elaborated from mutton meat (*Ovis aries*) and bovine meat (*Bos indicus*).

MATERIALS AND METHODS

Bovine and mutton meat were obtained at the local market of the city of Monteria, as well as the other needed ingredients and condiments; additions used to

Corresponding Author: Pedro Romero, Facultad de Ingenierías, Universidad de Córdoba, Programa de Ingeniería de Alimentos, Carrera 6 N°76-103, Montería, 230001, Colombia

prepare the emulsions were provided by a company dedicated to the commercialization of said supplies for the food industry, also located in Monteria.

Mutton meat was put through a mincer (JAVAR-22) using a disc 6, evening it out, then packed in sample containers previously sterilized and afterwards stored at 4°C. Out of each container the triplicated proximal analysis were: Protein (Macro Kjeldahl 955.45/AOAC, 2003), Humidity (Dried by stove 930.15/AOAC, 2003) and Fat (Soxhlet method NTC 4722/1999). For the functional properties, samples were taken from the mutton meat and triplicated analysis of the functional properties were: CRA (water retainer capacity) by compression (Honikel, 1988), CE (emulsifier capacity) (Yu *et al*., 2007) and direct reading pH.

Percentages and quantities of the different ingredients were established, making sure that only the bovine-mutton proportions variated in the following manner: 100-0 (100% mutton meat); 80-20 (80% mutton meat-20% bovine meat); 60-40 (60% mutton meat- 40% bovine meat); 40-60 (40% mutton meat-60% bovine meat); 20-80 (20% mutton meat- 80% bovine meat); 0-100 (100% bovine meat) the other ingredients remained the same; once the quantities of mutton and bovine meat were established, the materials were prepared. Meat was minced and salted at 2% with a mixture of sodium nitrite and stored (4°C/24 h), afterwards they were individually weighed (bovine and mutton) and the pork fat, then minced (JAVAR-22) using a N° 6 disc. After all the other ingredients were properly weighed, the emulsification took place using a cutter (JAVAR-10). From the total of the stuffed emulsion (Javar manual stuffer-15, caliber 22 cellulose in 60 g portions) were scalded at 70, 72, 74 y 76°C, until they reached a core temperature of 70°C. Afterwards, thermic shock with water was executed at 5°C until the scalded emulsion cooled down and then stored (5°C/24 h). After 24 h the samples were vacuum packed in cryovac bags and stored at 5°C until analysis were done. For the texture profile (TPA), cylinders were obtained from the vacuum packed samples, 2 cm high. For the measuring a Texturometer was used TA-XT PLUS, with a NEXIGEN software, by triplicate; for the color analysis a colorimeter Colorflex EZ was used, on the CIELAB scale (L*, a* y b*) and for the sensory analysis a tasting panel made up by 100 non-trained tasters selected randomly using the hedonic scale of 9 points.

Statistical analysis: A simple factorial A*B experiment was made under a completely random design (DCA). Factor A corresponds to the combination of meats (bovine-mutton) with 6 levels taken into account [(100-0), (80-20), (60-40), (40-60), (20-80) and (0-100) while factor B is temperature with 4 levels (70°C, 72°C, 74°C and 76°C). For the simple effects analysis, Duncan tests and orthogonal polynomials were executed, the interaction was analyzed through regression models or orthogonal polynomials for each meat combination. The correspondent validation tests were made (normality, variance homogeneity and randomization) on each case.

The sensory analysis provided by each taster and describer was evaluated using the univariate SAS software, version 9.1. Taking into account that the treatments codified as 9340, 6542, 8733, 4111, 6209, 7438, were re-coded as 1, 2, 3, 4, 5 and 6.

RESULTS AND DISCUSSION

In Table 1 the proximal analysis are shown, mutton meat presents an elevated percentage of protein, as opposed to traditional meat as pork (21.8%) and poultry (21.4%) reported by Lavin *et al*. (2007). Neverthless, authors like D'Alessandro *et al*. (2012) researched the bromatological characteristics in older ovines, finding protein results of protein (20.64%); water (70.63%) and fat (8.61%); results that are very far from the ones obtained in this study except for the protein; the same author reports data for milk goats similar to the ones obtained, protein (22.75%); humidity (16.31%) and fat (2.47%); which can help us infer that the animal obtained from the sacrifice was a relatively young ram, due to the fact that young animals contain very little fat in their bodies as well as a lower oleic acid content (predominant in the adipose tissue).

On the other hand the reported humidity content in this study was 16.74%, very similar to the ones reported by Wismer-Pedersen (1994) of 18.5% in male lambs close to turning one year of age. The same authors predict that "the water content changes depending on the greasing level of the channel and with the way of tearing it apart"

Results of the functional characteristics of the mutton meat are shown on Table 2:

The pH result of 5.28 matches the one obtained by Hamm (1977), where it is shown that most of the muscular tissue of the meat is within a pH range of 5.5 and 7; indicating a proper pre-sacrifice handling and the nonexistence of stressed meat because as opposed to pork and bovines, ovines are not especially susceptible to presenting pH alterations.

Table 1: Proximal analysis of mutton meat

Parameter	Result
Protein	*18.95±0.78
Humidity	*16.74±0.22
Fat	*2.86±0.23

*Average of 3 repetitions±Standard deviation

Table 2: Determination of functional characteristics

Parameters	Unit	Results
pH		*5.28±0.10
CRA	%	*62.98±0.59
CE	Ml oil	*38±0.15

* Average of 3 repetitions±Standard Deviation

Table 3: TPA analysis results

T°C	Formulation	Hardness	Adhesion	Elasticity	Cohesion	Gumminess	Masticability
70	100-0	3.87±0.12*	-6.96±0.12**	0.97±0.02*	0.92±0.11*	4.16±0.19**	1.54±0.23***
70	80-20	4.22±0.17^{ns}	-6.30±0.10*	0.98±0.09*	0.91±0.12***	3.85±0.10*	2.58±0.41***
70	60-40	3.49±0.22***	-4.92±0.27^{ns}	0.97±0.05^{ns}	0.91±0.11^{ns}	3.74±0.12***	1.35±0.36***
70	40-60	4.18±0.01^{ns}	-5.92±0.11^{ns}	0.97±0.02*	0.91 ±0.45*	3.98±0.34^{ns}	3.80±0.22^{ns}
70	20-80	4.27±0.11^{ns}	-4.04±0.20^{ns}	0.96±0.03^{ns}	0.91 ±0.19***	3.71±0.22^{ns}	2.37±0.18^{ns}
70	0-100	4.21±0.14*	-6.00±0.11^{ns}	0.98±0.05*	0.92 ±0.05***	3.67±0.25*	3.47±0.10***
72	100-0	4.57±0.16*	-9.47±0.22*	0.97±0.06*	0.91±0.15*	4.20±0.10**	1.55±0.17***
72	80-20	4.13±0.24^{ns}	-6.50±0.10*	0.96±0.08*	0.90±0.21***	4.43±0.10*	1.51±0.21***
72	60-40	4.46±0.26***	-4.33±0.22^{ns}	0.97±0.11^{ns}	0.91±0.45^{ns}	3.93±0.10***	5.01±0.38***
72	40-60	4.69±0.34^{ns}	-6.16±0.15^{ns}	0.96±0.15*	0.90±0.45*	4.05±0.10^{ns}	3.03±0.34^{ns}
72	20-80	4.22±0.10^{ns}	-3.71±0.18^{ns}	0.96±0.12^{ns}	0.89±0.18***	3.92±0.10^{ns}	1.40±0.23^{ns}
72	0-100	3.91±0.18*	-3.56±0.10^{ns}	0.98±0.14*	0.90±0.24***	3.26±0.10*	2.25±0.23***
74	100-0	4.53±0.23*	-4.74±0.08*	0.96±0.01*	0.91±0.23*	3.74±0.10**	3.45±0.12***
74	80-20	3.86±0.23^{ns}	-3.73±0.08*	0.98±0.02*	0.91±0.45***	3.21±0.10*	3.03±0.19***
74	60-40	3.98±0.14***	-4.78±0.05^{ns}	0.97±0.05^{ns}	0.91±0.34^{ns}	3.32±0.10***	3.14±0.22***
74	40-60	4.13±0.65^{ns}	-5.48±0.18^{ns}	0.98±0.02*	0.91 ±0.15*	3.44±0.10^{ns}	3.21±0.27^{ns}
74	20-80	4.19±0.34^{ns}	-4.52±0.12^{ns}	0.97±0.02^{ns}	0.91±0.32***	3.48±0.10^{ns}	3.24±0.23^{ns}
74	0-100	5.05±0.18*	-8.73±0.10^{ns}	0.96±0.03*	0.90±0.42***	4.16±0.10*	4.22±0.23***
76	100-0	4.62±0.56*	-5.23±0.23*	0.98±0.02*	0.92±0.23*	4.26±0.10**	3.95±0.22***
76	80-20	4.16±0.34^{ns}	-8.59±0.04*	0.96±0.04*	0.92±0.13***	4.22±0.10*	3.70±0.25***
76	60-40	4.59±0.23***	-6.52±0.10^{ns}	0.98±0.01^{ns}	0.92±0.23^{ns}	3.82±0.10***	3.81±0.11***
76	40-60	4.32±0.13^{ns}	-3.12±0.89*	0.96±0.01*	0.91a±0.22*	3.95±0.10^{ns}	3.59±0.15^{ns}
76	20-80	3.91±0.16^{ns}	-4.11±0.01^{ns}	0.96±0.02^{ns}	0.90±0.22***	3.57±0.10^{ns}	3.44±0.07^{ns}
76	0-100	3.98±0.16*	-4.58±0.18^{ns}	0.98±0.04*	0.92±0.15***	3.69±0.10*	3.51±0.07***

*Denotes significant differences at p≤0.05; ** Denotes significant differences at p≤ 0.01; *** Denotes significant differences at p≤0.001

If we take into account that young animals present more pH l owerage (Serra *et al*., 2004; Gil *et al*., 2001) and that slight pH differences have been reported among breeds of the same species (Sañudo *et al*., 1997), a comparison can be made between the pH of this study and the one described by Vergara *et al*. (2002), for Manchego lambs in 7 days with a value of 5.61, close to the information obtained in this study

The CRA results of 62.98 are relatively high and differ with studies reported by Adan *et al*. (2011) where CRA measurements of 34.64 were reported on Galician sheep of 45 days and also differs from studies made by Bianchi *et al*. (2006b), where CRA of 25.06 is reported. This water retention ability high CRA (62.98) play an important part from the organoleptic, nutritive and technological point of view; from the organoleptic point of view it considers texture, juiciness, color, toughness of the meat. From the nutritional point of view it can originate water loss, as well as the nutritional kind and hydrosoluble vitamins and from the technologic point of view regarding loss over dripping (Gil and Sánchez de Medina, 2010).

For the emulsifier capacity CE the results indicate that mutton meat has a CE of 38 mL of oil/g which allows to establish the fact that this meat holds an excellent ability to form emulsion and therefore offers the possibility of being transformed in any emulsified product. These results differ from the ones delivered by Cury *et al*. (2011), where a CE of 24.83 mL of oil/meat was reported for rabbit Abugoch *et al*. (2000) and that reported CE of 410 mL of oil/meat for Jaiva meat and 755 mL of oil for soy isolate.

Table 3 shows that for the attribute of Hardness, the formulations 20-80, 40-60 and 80-20 do not present significant differences (p>0,05); the formulations 100-0 and 0-100 presented significant differences (p≤0.05) and the formulation 60-40 presented highly significative differences (p≤0.001). The lowest hardness point was reached when a temperature 70°C was applied and the maximum point with a formulation of 100% mutton meat and a 74°C temperature. At 76°C is when each of the formulations appear to take their highest hardness values, except the 0-100 and 20-80 formulations. The result matches the fact that when a thermic process is started, humidity is lost, therefore incrementing hardness (Carballo *et al*., 1996).

For the adhesion attribute, formulations 60-40; 40-60; 20-80; and 0-100 did not have significant differences (p>0.05), but for 80-20 and 100-0 formulations there were differences (p≤0.05); reaching a maximum adhesive value when it comes to 100% bovine meat with a 72°C temperature and a lower value with 76°C temperature and a 40-60 formulation.

For the elasticity attribute it is shown that in spite of being similar on some formulations, the general tendency differs, therefore no significant differences were found for 20-80 and 60-40 formulations (p>0.05).

For the cohesion attribute, formulations 100-0 and 40-60 presented significant differences (p≤0.05), while for 0-100, 20-80 and 80-20 highly significant differences were shown (p≤0.001) and for 60-40 formulation there were no significant differences (p>0.05), the cohesion showed a minimum value when 20-80 formulation was used at 72°C.

For the gumminess attribute, formulations 20-80 and 40-60 do not present significant differences (p>0,05); 80-20 and 0-100 formulations presented significant differences (p≤0.05) while 100-0 and 60-40 formulations presented highly significant differences (p≤0.01). Gumminess showed minimum values when

Table 4: Colorimetry results. Average of 24 experiments with three replicas

T°C		L*	a*	b*	T°C	L*	a*	b*
70	100-0	$60.51\pm1.15^{**}$	$9.63\pm0.79^{**}$	13.07 ± 0.56^{nss}	74	$59.65\pm3.78^{**}$	$10.06\pm1.3^{**}$	12.95 ± 0.34^{ns}
70	80-20	$59.36\pm2.33^{**}$	$10.42\pm0.58^{*}$	$13.63\pm0.14^{*}$	74	$55.87\pm2.12^{**}$	$11.36\pm0.55^{*}$	$13.29\pm0.37^{*}$
70	60-40	57.03 ± 0.13^{ns}	11.0 ± 0.14^{ns}	$13.77\pm0.32^{*}$	74	57.99 ± 1.22^{ns}	10.81 ± 0.04^{ns}	$13.66\pm0.12^{*}$
70	40-60	$56.9\pm1.32^{**}$	$11.14\pm0.2^{*}$	$14.09\pm0.75^{*}$	74	$56.77\pm2.61^{**}$	$10.85\pm0.82^{*}$	$13.78\pm0.15^{*}$
70	20-80	$55.58\pm1.65^{*}$	$11.13\pm0.5^{*}$	$14.24\pm0.7^{*}$	74	$54.16\pm2.16^{*}$	$11.67\pm0.48^{*}$	$13.93\pm0.92^{*}$
70	0-100	57.23 ± 1.54^{nss}	$10.63\pm1.00^{*}$	$14.94\pm1.87^{*}$	74	56.32 ± 3.33^{ns}	$11.19\pm1.13^{*}$	$14.85\pm1.9^{*}$
72	100-0	$59.47\pm2.93^{**}$	$10.67\pm0.79^{**}$	12.88 ± 0.72^{ns}	76	$58.07\pm1.36^{**}$	$10.92\pm0.32^{**}$	12.95 ± 0.71^{ns}
72	80-20	$56.54\pm2.34^{**}$	$11.4\pm0.66^{*}$	$13.62\pm0.32^{*}$	76	$56.71\pm0.18^{**}$	$11.24\pm0.4^{*}$	$13.66\pm0.54^{*}$
72	60-40	58.04 ± 3.36^{ns}	10.74 ± 0.63^{nss}	$13.92\pm0.08^{*}$	76	56.53 ± 2.62^{ns}	10.84 ± 1.00^{ns}	$13.12\pm0.44^{*}$
72	40-60	$55.91\pm1.26^{**}$	$11.37\pm0.05^{*}$	$13.84\pm0.29^{*}$	76	$53.92\pm0.1^{**}$	$11.84\pm2.45^{*}$	13.44±0.23*
72	20-80	$54.1\pm1.25^{*}$	$11.68\pm0.28^{*}$	$14.13\pm0.29^{*}$	76	$53.82\pm2.47^{*}$	$9.69\pm1.7^{*}$	$13.67\pm0.61^{*}$
72	0-100	55.37 ± 1.27^{ns}	$11.43\pm0.25^{*}$	$14.28\pm0.15^{*}$	76	56.29 ± 2.46^{ns}	$11.09\pm0.17^{*}$	$14.28\pm1.33^{*}$

*Denotes significant differences at p≤0.05; **Denotes significant differences at p≤0.01; ***Denotes significant differences at p≤0.001

sausages were subject to a 74°C temperature, a 80-20 formulation was used and a maximum gumminess value when a 80-20 formulation and a 72°C temperature was used.

For the mastication attribute, formulations of 20-80 and 40-60 do not represent significant differences. Meanwhile, the rest of the formulations showed highly significant differences (p≤0.001). Mastication presented the minimum values when a 60-40 formulation was used at 70°C and a maximum value when a 0-100 formulation was used at 74°C. That said, it can be confirmed that the mastication work of the sample to the swallowing point is exactly the same on all the formulations submitted to 74°C except formulation 0-100 of 100% bovine meat, this is due to the fact that different breeds of bovines present different percentages of meat tenderness (Marshall, 1999) which ultimately defines that the tenderness is the result of a balance between two opposite processes: one reducing it due to actin-myosin reinforcement and the shortage of the sarcomere within the first 24 h and another one that produces tenderness with the weakening of the myofibril protein union associated with a proteolysis process (Taylor *et al*., 1995). Another influential factor is the marbled meat level and the connective tissue content that can explain up to 20% of the variation of tenderness between animals (Crouse *et al*., 1989).

The same result was reported by Cheng and Sun (2004) when evaluating the effects quality has on ham, influenced by cooking and storage methods, as Goff (2004) and Guerra and Cepero (2004), in a study about starch stability on food, reported that the syneresis presents an increment because of temperature fluctuations generated during the cooking process because of the insoluble precipitation of the amylose molecule as the lineal chains are parallel-oriented and interact with each other thanks to hydrogen bridges by multiple hydroxyl groups, altering, at the same time, the texture properties of the product. For the adhesive property, the obtained results were negative, which indicates that the texture is sticky, adding extra effort to remove it from the palate.

On the other hand, Thomas *et al*. (2008) reported adhesive values of -0.014 N.s in pork sausages, very low values compared to the ones obtained in this study; it is important to remember that if temperature is taken into account on each of the formulation levels, it can be concluded that significative differences only exist on the 100-0 and 80-20 formulations. The elasticity attribute shows uniformity or similarity on the formulation behaviors, for each temperature range.

The cohesion results of this study are similars to the ones reported by Xiong *et al*. (1999) with 0.79 values for bovine meat sausages, but differents from the ones obtained by other authors like Andrés *et al*. (2009) reporting cohesion values of 0.57 for chicken sausages made with bovine fat; Leyva-Mayorga *et al*. (2002) report values very lows from the ones obtained in this study with 0.574 for bovine meat sausages and pork fat; at the same time these results were higher than those reported by Ríos (2004) who reported values of 0.61 for commercial chicken sausages.

Table 4 shows that for L* (Luminosity) there are highly significant differences (p≤0.01) for 100-0, 80-20 and 40-60 formulations, the 20-80 formulation presented significant differences while 60-40 and 0 100 formulations did not present significant differences (p>0.05); the highest luminosity value is obtained in the 100-0 formulation at 70°C and the lowest in the 20-80 formulation at 76°C.

The value a* (green-red hue) showed highly significant differences (p≤0.01) for 100-0 formulation. The rest of the formulations presented significant differences of p≤0,05, the red hue being highest in 40-60 formulation at 76°C and the lowest red gue in 100-0 at 70°C. Formulation 60-40 did not present significant differences (p>0.05).

The value b* (yellow hue) presented significant differences of (p≤0.05) in all of the formulations except 100-0, which did not present significant differences (p>0.05). The maximum yellow hue is in 0-100 formulation at 70°C and the minimum yellow hue in 100-0 formulation at 72°C.

Some authors have found that lowering the fat content on a sausage, the L values also go down (Carballo *et al*., 1996; Berry, 1998). Liste *et al*. (2004) found L parameter values of 37.8, lower than the ones reported in this study; it is important to remember that

Table 5: Obtained results of Univariate SAS v.9.1., of all the evaluated attributes on different treatments

TTO	Appearance	Color	Smell	Texture	Flavor
100-0	5.76 B	5.54 B	6.79 A	6.27 B	6.32 B
80-20	6.16 AB	6.31 A	6.70 A	6.52 B	6.57 B
60-40	6.14 AB	6.39 A	6.51 A	6.25 B	6.49 B
40-60	6.28 AB	6.04 AB	6.95 A	7.12 A	7.24 A
20-80	6.23 AB	6.27 A	6.50 A	6.81 AB	6.84 AB
0-100	6.66 A	6.63 A	6.73 A	6.55 AB	6.83 AB

Table 6: Percentage results of the measurements of all the evaluated attributes on different treatments

TTO	Appearance (%)	Color (%)	Smell (%)	Texture (%)	Flavor (%)
100-0	64	61.6	75.4	69.7	70.2
80-20	68.4	70.1	74.4	72.4	73.0
60-40	68.2	71.0	72.3	69.4	72.1
40-60	69.8	67.1	77.2	79.1	80.4
20-80	69.2	69.7	72.2	75.7	76.0
0-100	74.0	73.7	74.8	72.8	75.9

said parameters are influenced most of the time by temperature and the amount of glucose (Pearson and Tuber, 1984).

The L parameter is the one that provides the most information regarding changes of color in meat and other meat products (Ayo *et al*., 2007) these changes most of the time are because of the Maillard reaction, that happens when the food is subject to high temperatures (Chua *et al*., 2001) and also because of the denaturalization of proteins, fat and dehydration (Piñero *et al*., 2008).

The color of meat is given by myoglobin and metmyoglobin pigment concentration (Conrad *et al*., 1967). If myoglobin content is compared in different kinds of meat, it can be observed that bovine meat contains 15 mg/g of myoglobin, while ovine meat contains 10 mg/g (Livingston and Brown, 1981); which would explain the variations of a* in each of the formulations, having the lowest value for red on 100-0. Authors like Lawrie (1985) expressed that differences in the amount of myoglobin in the muscle explain the color differences.

The 20-80 formulation was the one that presented an redder hue, as opposed to the expected from Livingston and Brown (1981) were the 0-100 one; nevertheless this can also be due to physicochemical factors as pH (Lehninger, 1982), breed, species and gender that have an influence over the amount of pigments present on meat (Livingston and Brown, 1981; Renerre, 1996).

Value b* representing the yellow hue was higher in0-100 formulation at 70°C (chart 10); Synder (1965) proved that an elevated a*/b* indicated a high concentration of myoglobin or MbO2 on meat, which matches the results, as the formulation presents 100% of bovine meat; at the same time disagreeing with studies made by Fernandez-López *et al*. (1998) where myoglobin concentration is not a determining factor on the matter, because if it was, a similar behavior would be expected to the one obtained in a*. Nonetheless, meat with fat presented values of b* similars to the ones obtained for lean meat. This behavior can be due to a higher contribution by fat on the yellow hue and therefore a* can be useful to predict myoglobin concentration and the color of meat (Kang *et al*., 1998)

For sensorial analysis, significant differences were found ($p \leq 0.05$) on some attributes and on others, the non-existence of significant differences ($p > 0.05$), on Table 5 and 6 the results are shown:

For smell, texture and taste attributes the highest scores obtained were from the sample of 100% mutton meat, which shows the great acceptance of this type of meat by consumers. In the sensorial evaluation (Table 5), it can be observed that evaluations did not pass 7, "I moderately like it.

One of the reasons why, could be an error of central tendency, as all of the data were grouped in the center of the scale, behaviour presented when panelists seem to doubt third evaluations and tend to assign intermediate values (Sánchez and Albarracin, 2010). According to Emma (2001) this error in panelists can also present itself because of the lack of familiarity with this type of foods which provokes lack of confidence when it comes to selecting any extreme of the scale. Some studies highlight the preferences of the panel are highly influenced by the origin of the meat, giving more value to the products they are used to and somehow rejecting the new and unknown products (Griffin *et al*., 1992; Bianchi *et al*., 2004).

The results in the scale evaluation suggest that the previous knowledge of a product, familiarity and eating habits are tightly related and influential on the grade given by the testers (Bianchi *et al*., 2004).

On the other hand the texture in meat products is determined by humidity and fat contents, as well as the amount and type of proteins and structural carbohydrates (Aktas and Kaya, 2001), the most accepted sample regarding texture was 100% mutton meat, which showed the potential said meat possess for the elaboration of cold meats (stuffed). Also, recent studies indicate that grass-fed ovines-as opposed to bovines, pork and poultry-present higher polyunsaturated acid values, specially Omega3, as well as isomers from linoleic acid (Garcia, 2004).

The same author (Garcia, 2004) reported that ovine meat produced in grass systems compared to the meat produced in intensive systems is leaner, with less trans fat and cholesterol, has a higher Omega3 percentage and an optimum Omega6-Omega3 relation, which could explain the texture acceptance in sausages made 100% with mutton meat.

For appearance and color attributes, samples that obtained the most acceptance were 40% mutton and 60% bovine, which was expected because the color difference that was previously observed in all the formulations and that formulation was almost half: not so dark and not too dull to be rejected.

When it came to the ‘buying sausages’ initiative, the results were satisfactory: 89% manifested they would buy the product. This was brought by the opinion of usual consumers, which is meaningful taking into account they reflect a higher acceptance level towards sausages made 100% from mutton meat. The results reflect acceptance and possible use in the elaboration of cold meats.

CONCLUSION

Mutton meat presents favorable characteristics for transformation and because of the nutritional and functional characteristics it possesses, to be used in the agro industrial field. It also contains a significant amount of proteins (18.95%) and humidity (16.74%). The emulsifier capacity that mutton meat has (38 mL of oil/g of meat) guarantees the formation of good quality emulsion and therefore can be used to elaborate sausage-type products.

The general Texture Profile Analysis (TPA) shows a highly significant interaction between the temperature and formulation variables, therefore the behavior of some formulations differ on each of the studied temperatures. The scalding temperatures are a significant influence on the Hardness textural parameter, reflecting a directly proportional behavior; which goes up when the temperature does too.

Luminosity L* was higher on the 100% mutton meat formulation and the lowest on the 20-80 formulation. Also, L* is highest when the emulsion is at 76°C and *L** is lowest at 70°C. Formulation and temperatures of the scalding process affect L* and a* and maximum values are obtained when subject to high temperatures and minimum values when subject to lower temperatures, the emulsion represented by 100% mutton meat was the one that presented lower reddish hue due to the lower hemoglobin pigment content. The value of b* (yellow hue) varies on the emulsions depending on the applied scalding temperature and the amount of mutton and bovine meat used, this way obtaining a maximum yellow hue at a 70°C temperature and a minimum yellow color for 76°C temperatures.

For sensorial attributes of smell, texture and flavor the highest scores were obtained by the 100-0 formulation (100% mutton meat), which proves the great acceptance of this type of meat among consumers and the possible utilization of it in the meat industry.

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CONFLICT OF INTEREST

This Project was financed entirely by the University of Córdoba, Colombia so, its development has as sole purpose the generation of knowledge avalaible to the scientific community as well as to the produce guilds.

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