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Processing and quality Of « Charmout » A Dry And Spicy Meat From The Lake Chad Basin

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ABSTRACT: *Peppered Charmout is a meat product originating from Chad, obtained by drying strips of beef previously seasoned with salt, white pepper and chili. It is produce using empirical processes at family scale. This work aims at studying artisanal production process of peppered Charmout, in order to identify critical points and propose actions to master theses critical points, with the aim improving the quality of Charmout. To do this, the work consisted of describing the main stages of artisanal production, then standardizing some production parameters, following physical modifications of meat during the stages of production, produce a peppered Charmout according to the improved methods and apprehend the qualities of produce Charmout through the sensory analysis.*

KEYWORDS- *Chad, Cameroon, Dry-Meat , hygienic, HACCP, nutrition.*

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I. INTRODUCTION

Charmout is a traditional Chadian meat product obtained after drying beef strips seasoned with white pepper and salt [1]. This dried meat is used in Chadian and Sudanese cuisine for the preparation of a sauce, called "Charmout sauce" or "tagalié" [2]. It can be eaten with wheat bread as well as a local sorghum bread called “kisra”. It’s also mainly use to accompany a millet porridge main dishes called “esh” [3, 4]. The “Charmout” is the only form of traditional meat preservation in northern Chad and is an essentially female activity [3]. The processing of this meat product remain homemade and is made in poor hygiene conditions [5]. The cutting operations are done on old mats on the ground and drying on old ropes. The final dried product itself is conditioned in second hands bags and stored in at room temperature witch is around 45° in local area [5, 1]. The commercialization of the product is made conditioned in bag to wholesalers and can be transported for around 1000km in open Lorries, for distribution in local market [6, 4]. The risk of contamination during processing and storage was reported to be very high [2]. The poor processing condition add to bad distribution system can foreseen a non-constant organoleptic and nutritious quality product with poor hygienic quality. Despite this, the Charmout is source of animal protein for thousands of local population and provides women with a significant income [7]. It’s therefore necessary to improve the organoleptic and hygienic quality of the product. This can only be achieves by investigating the processing condition to highlight and master the critical point during processing and thus expect getting better and safe product which can be integrate it into the sub-region for the sake of its promotion at international level.

II. MATERIAL AND METHODS

II. 1. Data collection and process design

Data collection on the “Charmout poivré” process production were recorded according to ethnographic methods as described by Schensul *et al.,* [8] associated with focused group discussion method of Bertrand, *et al.,* [9]. The sample size and localization of groups were access as describe by Wears [10] clustering method. The population were Chadian community residing in Maroua and Kousseri town in Northern Cameroon.

II. 2. Raw material for laboratory scale production

The production of “Charmout” requires the use of various materials (meat) [2]. The main material was beef bought from a butcher in Domayo (Djarma crossroads) and at the Maroua slaughterhouse market. The

muscles chosen were the sirloin, muscle of the first category (the most tender) and the round of heel, muscle of the second category (moderately tender) of the beef carcass.

The beef muscles were divided into 3 categories according to their tenderness (category 1 the most tender, category 2 the moderately tender and category 3 the least tender). The choice of muscle is a determining step for the final tenderness of the product. This is what justifies the choice of two muscles.

To enhance the flavor of the final product, spices such as cloves, slices, cinnamon, and white pepper, salt, were purchase from local market. This plants material used for the formulation of the seasoning ingredient cocktail.

II. 3. Ameliorated flow sheet of "Charmout" production

Sample of the 25 interviewed women during focus groups discussions were called to assist in preparing "*Charmout*" according to an ameliorated flow sheet, based on their interviews during focus group discussion in the field and mastering some critical points. During this laboratory preparation, some steps were harmonized and corrected according to their observations. Samples of prepared laboratory *Charmout* were collected for biochemical and sensory analysis. Fourth groups of "*Charmout*" named: *Charmout* with Sirloin fresh, *Charmout* with Sirloin Maturated 24h at 0°C, *Charmout* with Round of heel fresh, *Charmout* with Round of heel Maturated 24h at 0°C; were produced from the two muscles of the beef carcass, one sample without maturation and the other after maturing for 24 hours, in a freezer (temperature close to 0°C). The stages in the production of "*Charmout*" at the laboratory scale were as describe in Fig I below.

II. 4. Sensory analyses

Artisanal *"Charmout"*, laboratory scale *"Charmout"* (*Charmout* sirloin fresh, *Charmout* Sirolin Maturated, *Charmout* Round of heel fresh, *Charmout* Round of heel maturated) and one commercial Bilton purchased from the local market, were presented to a panel of experienced tasters comprising ten members of regular meat eaters. The sensory analysis procedure suggested by Rivella [11] was used. Each taster was given an evaluation form for each of the dry meat samples. The form included five sensory attributes: Preference, taste, aroma, visual examination (Color and overall appearance), and harmony (overall acceptability). Panelists were asked to assess the samples in terms of the listed attributes using a nine-point hedonic scale with 9 representing like extremely and 1 indicating dislike extremely. The tasting was carried out in a highly illuminated tasting room. Tasters were provided with water to rinse their mouth after each round of tasting and were prevented from communicating with each other to avoid undue biases. Each taster was served with 25 mg of each dry meat sample in different coded form.

II. 5. Statistical analysis

Data was subjected to analysis of variance and means were separated using Duncan's multiple range test at $P < 0.05$ [12].

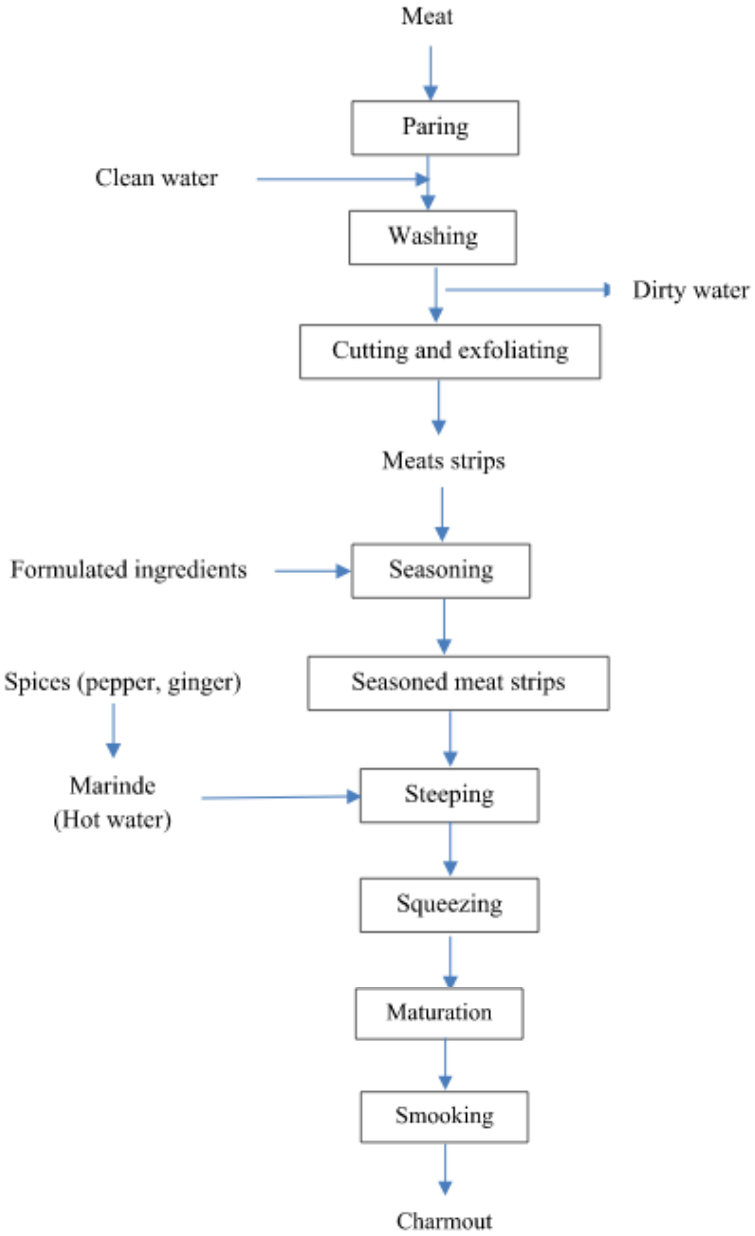

Fig I: Flow diagram of laboratory method of "Charmout" production

II. 6. Physicochemical analyses

The different elements that have been analyzed in this part are those on which the appreciation of the final product strongly depends. These are:

Weight / volume: It was found necessary to weigh the muscle and strips after key operations such as Paring, Seasoning/Steeping, Maturation and smoking to determine the percentage of losses by operation and overall. The volume of water used at the entry and exit of marinade were also recorded for the same purpose.

Size of the strips: The length, the width, the thickness of the muscle (meat) and their evolution from the cutting to the exit of the smoking were followed for each production. This was as follows. Using a well-used butcher's knife, we sliced / unrolled the muscle as thinly as possible. We used the ruler to regularize the length, width and thickness of the strips, then took the dimensions of 3 samples (strips) per production using the caliper and compared them to those of these strips after marinating and drying. This made it possible to explain the behavior of the straps after these operations.

Water content and pH: The pH and the content are chemical parameters of an important technological interest on which the shelf life of a product depends. Lowering the pH increases the shelf life [13] as does the water content. These parameters were determined at the essential points of production, namely, at collection point, after marinating and drying. For pH, we collected 5 g of the test item (muscle, precooked strap, Charmout

) which was milled with 10 ml of distilled water, in which the introduction (3 times until constancy) the tips of the electrodes of the pH meter (Bluelab combo meter) made it possible to read the acidity of the product .

II. 7. Proximate composition:

AOAC methods [14] were used: drying at 105°C for moisture (method 925.098); incineration at 550°C for ash (method 923.03); defeating in a soxhlet apparatus with 2:1 chloroform/methanol, for total fats (method 920.39C with minor modifications); and micro Kjeldahl for protein (Nx6.25) (method 960.52). Total carbohydrates were estimated by difference.

II. 8. Microbial analysis

10 g of "Artisanal *"Charmout"* was mixed with 90 ml sterile peptone physiological saline solution (1 g Peptone, 8.5 g NaCl and 1000 ml distilled water). Decimal dilutions were prepared up to 10^6 from initial sample as describe by Loyer, & Hamilton [15].

Total aerobic mesophilic bacteria was enumerated on Plate Count Agar (PCA-OXOID) supplemented with cycloheximide 0.5% as describe by Smith, & Busta, [16]. The plates were incubated at 28°C for 48 to 72 h.

Total coliforms and Escherichia coli were accessed on Bubble Lactose Bile with Brilliant green (BLBVB- DIFCO). The petries dishes were incubated at 30°C for 24 to 48 h. The positive petries dishes were used to inoculate a test tube containing water peptone without indol and were incubated at 44°C for 24 h for *E. coli* determination. *E.coli* was revealed using Kovac's reagent [17]. Total coliforms and *E. coli* were evaluated by the method of the most probable number.

Staphylococcus aureus was enumerated on Manitol Salt Agar (MSA - Sigma) and revealed by the coagulation test with rabbit's plasma. The plates were incubated at 37°C for 48 h. Fecal Streptococcus was enumerated on Slanet Agar (SL-Merck) supplemented with Cycloheximide at 0.5% after 48 h of incubation at 37°C [18].

Salmonella and Shigella were analyzed as describe by Mossel [19]. Yeasts and molds were enumerated on YPD-Chloramphenicol (200 g yeast extract, 10 g peptone, 20 g glucose, 20 g agar, 0.5 g chloramphenicol and 1000 ml distilled water) after 48 to 72 h of incubation at 30°C Enumeration of sulphite- reducing clostridia were done according to Mossel, [19] method in anaerobic jar. All enumeration in solid media was carried out in triplicate and the plates containing between 33 and 333 colonies were considered. The enumeration in liquid media was evaluated according to the most probable number.

III. RESULTS AND DISCUSSION

III.1 Artisanal production of "Charmout"

The *"Charmout"* is processed according to an old Chadian method and represents the only traditional form of meat preservation in this country. Briefly described, the normal *Charmout*, is a deboned meat cut into strips of about 1 cm wide and placed to dry on a wire in the sun (Fig II).

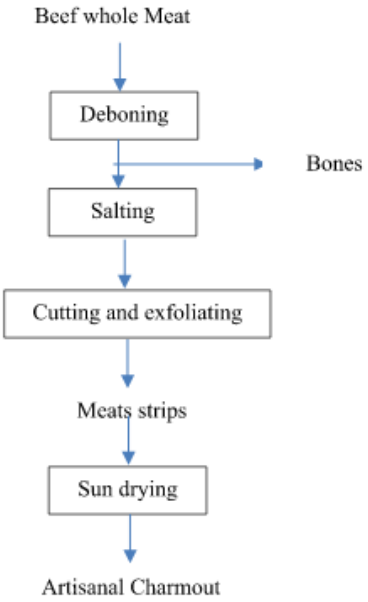

Fig. II: Artisanal processing of Chadian *Charmout*

The preparation of the *"Charmout"* is essentially a feminine activity [2, 4]. It is practiced individually or collectively, and generally constitutes a method of valuing meat from lean animals sold at low prices [3, 2]. This activity is therefore quite remunerative, especially when practiced in rural areas where animals are the cheapest. By partnering with more than one, women can more easily acquire a whole carcass or leg which is then cut up and prepared together. The *"Charmout"* is mainly produced from beef, but we also sometimes find *"camel Charmout"* [2, 5]. Some women have even organized themselves into formal associations for processing and commercialization of *"Charmout"* at semi industrial level.

According to de focus discussions and individual interview, the essential steps and critical points in the process production of *"Charmout"* are describe in fig 2. The mains steps witch can be seen as critical points are: the choice of the muscle, cutting of meat into thin strips, formulation of the ingredients, the duration of the marinade in boiling water and the step of smoking and drying. The following steps (fig 1) describe the proposed ameliorated artisanal process production of the *"Charmout"*. This was further use for production of standard *"Charmout"* at the laboratory scale.

Choice of muscles: The whole beef meat is mainly use without any choice in artisanal process. This can explain the variation in sensorial and physical properties (tenderness, texture…) of artisanal *"Charmout"* [20]. In other to stabilize the final product we proposed at the laboratory level to use on type of muscle rather than a mixture of muscles. The tender muscle of the round of heel after maturation of 24 is often used in the absence of the sirloin. The tenderness of the roost after maturation of 24 has become almost equal to that of the sirloin [21]. This confirms the statements of many researchers, including Cartier and Moevi [22], according to which during muscle maturation, proteases act like scissors and gradually cut the fibers of the muscle improving its tenderness [23]. It is after their reactions combined with those of lipases that the muscle turns into meat

Trimming and washing: This is done in order to removes aponeuroses, covering fat, connective tissue or other undesirable parts that can negatively influence the processing steps or the quality of the end product [24]. The muscle were washed with tap water and kept for further steps; This step is say to be an critical point for sanitation of final product [25] thus must be control to ensure safety of end product.

The next step is maturation: The purpose of maturation steps is to enhance all the organoleptic qualities of the meat [26, 27]. This operation is compulsory steps necessary to convert muscle to meat according to the standard. It consisted of introducing the clean trimmed muscle (round of heel) in freezer for 24 hours. It tenderizes the meat and gives it its characteristic flavor [27, 21]. This is said to be liked with enzymes (protease and lipase) activity [28];

Cutting and rolling in strips: The purpose of this steps is to remove surface dirt and microorganisms from meat and to reduce thickness to ease both drying and spicing [29, 30]. This is done by slicing the clean meat into strips of 2 to 3 mm thick and 11 ± 2 cm long. Measurements of thickness, length, and width were taken using a caliper and a graduated ruler. The cut is made in the direction of the length of the muscle to give the *"Charmout"* its final shape.

Ingredient formulation: The ingredients used are in the following table. The quantities were slightly readjusted for cloves, ginger and cinnamon.

Table 1 : Ingredients use for *« Charmout »* processing at laboratory level

Ingredients	Quantity for 1kg of meat
Salt	15
Pepper	3
Ginger	3
"Five spices"	3

Seasoning and mixing: This steps aims at mixing meat with ingredients such as spices, salt and vinegar. The use of vinegar is to lowers the pH of the medium and inhibits some bacteria while helping to tenderize the meat [31, 32]. Salt contributes to the flavor and decreases the water activity of the meat [33, 34].

Marinade the strips (muscles slices) with a mixture of boiling water and prepared "marinade". This marinade is a seasoned liquid preparation, often based on oil, in which pieces of meat or fish are soaked for a few hours to tenderize them and modify their taste [35, 36]. In our case, the marinade consists of bringing the tap water to a boil, then spilling it onto the strip previously mixed with the ingredients (i.e. salt, ginger, white pepper, vinegar) in a container. This operation lasts 30 minutes and allows the pieces of meat to absorb the aromas of the spices, and results in partial cooking of this.

Table II : Formulation of « five spices » for « *Charmout* » processing at laboratory level

Ingredients for ⟨⟨ five spice slury⟩⟩	quantities (g)
White pepper	65
clove	3
Ginger	13
Canella	15

Squeezing and second seasoning: Squeezing step consists of removing pieces of meat from water, placing them in a colander and allowing them to drain. The meat still loses a quantity of water. The precooked strips are then seasoned a second time with a precise amount of spice (white pepper, ginger, round, salt). The strips are left to marinate for 30 minutes in marinade.

Sun-drying/ Smoking: In artisanal process, the seasoned and marinated meat are lye in sun to allow it drying. This steps was replace in laboratory processing by smoking. This is because sun drying was found to be a critical point for sanitary safety [37, 38]. At this level we observed that the lye meat was in constant contact with fly insects and dust. This can explained bad hygienic quality of artisanal "Charmout" (Table III). It was also observed that sensorial attributes varies between one batches to another (fig. 3). This can be explained by the variation at the levels of sun intensity [38, 39]. The sun dry steps was replace by smoking in laboratory improved method. This was done as hot smoking may preserves the meat through cooking, dehydration and the protective action of the components of the smoke [40, 41, 42]. The meat was subjected to a smoke with a temperature which varies between 50 ° C to 60 ° C. Smoking may also improves the organoleptic quality, while promoting the stability of the product during long term storage at room temperature [38, 43]. During smoking, not only a significant loss in the quantity of water from the strips is noticed, but also an improvement in the organoleptic quality of the product certainly due to the Maillard reaction which occurs [44, 45].

III.2 Variation of water content during "Charmout" production

According to Table III, the total water losses of meat during production are respectively 52± 10% for artisanal *Chamout*, 41 ± 0.58% for *Charmout* made with fresh Sirloin, 62 ± 1.4% for *Charmout* made with Sirloin Maturated 24h at 4° C, 77.6 ± 0.56% for *Charmout* made with fresh Round of heel and 79.6 ± 0.56% for *Charmout* made with Round of heel maturated 24h at 4° C. We can also notice that smoking steps and the maturation seems to be the step were more water is removed than other [46]. However the low rate of water removal from drying step can be explain by the fact that at this level major water is already removed during smoking and maturation [34, 37, 46]. The Round of heel Maturated 24h at 4 ° C *Charmout* seem to be dryer than other samples with an water content of 20.4±0.5 while the Sirloin fresh Charmout present the higher water content (59±0.9) (Table3). The Seasoning step is clearly a steps in the process were the water content increase (Table III) this may be link to the fact that the marinade is liquid like [47].

The mean water content of artisanal *Charmout* was found to be 48±15 with high standard deviation (±15). This can be linked to the non-control of the temperature during smoking and on the other hand to the non-uniform / identical size of the strips given that the cutting was done manually [41, 47, 48].

Table III: Losses or gaining of water in % after some critical points in "*Charmout*" production

	Losses or gaining of water in % during some Critical points				
Productions system of *Charmout*	Paring	Seasoning	Maturation	Smoking	Drying
Artisanal *Charmout*	-2.00±0.8^{cd}	+5.30±0.9^{e}	NA	NA	-55±0.9^{a}
Sirloin fresh *Charmout*	-6.70±0.1^{b}	+8.00±0.5^{d}	-20±0.7^{a}	-40±0.8^{c}	-5±0.8^{c}
Sirloin Maturated 24h at 4°C *Charmout*	-1.30±0.0^{e}	+12.2±0.3^{bc}	-18±0.5^{ab}	-55±0.5^{b}	-8±0.7^{b}
Round of heel fresh *Charmout*	-10.0±0.5^{a}	+15.4±0.1^{b}	-15±0.8^{c}	-54±1.8^{b}	-4±0.6^{c}
Round of heel Maturated 24h at 4°C	-3.70±0.2^{c}	+19.7±0.8^{a}	-23±0.9^{a}	-62±0.7^{a}	-10±0.5^{b}

NA: Not applicable

Mean values preceded by at least one common letter in the same column are not significantly different ($p < 0.05$) according to the ANOVA and DUNCAN comparison test.

Comparing globally the effects, we can notice that drying artisanal *Charmout* seems similar to smoking in "ameliorated *Charmout*" production system with more than 50% water removal.

III.3 Variation of the length, width, thickness of the straps during "Charmout" production

To highlight the behavior of the strips between the key production operations, we took data at 3 levels: The length, width and thickness of 3 samples, more precisely of the strips at the entrance of the marinade, at the exit marinade that is to say boiling water and at the end of the smoking / drying. Table IV gives us details.

Table IV: Variation of the length, width, thickness of the straps during "Charmout" production

Steps	Length	width	thickness
Before Paring	11,18±0,78[a]	1,88±0,7[a]	2,37±0,02[a]
After Paring	0,29±0,03[c]	0,09±0,02[c]	0,16±0,00[e]
Before Maturation steps	11,47±0,58[a]	1,97±0,08[a]	2,53±0,03[a]
After Maturation steps	1,09±0,01[b]	0,77±0,47[b]	0,45±0,03[c]
Before Smoking	10,38±0,98[a]	1,20±0,13[ab]	2,08±0,04[b]
After Smoking	0,80±0,02[c]	0,68±0,07[b]	0,29±0,06[d]

Mean values preceded by at least one common letter in the same column are not significantly different ($p < 0.05$) according to the ANOVA and DUNCAN comparison test.

The size of the strips first increase just after the marinade and then decreases after drying. The increase after paring step is 0.29 ± 0. 3 cm in length, 0.09 ± 0.02 cm in width, and 0.16 ± 0.00mm in thickness. But after smoking the dimensions of the length, width and thickness respectively decrease by 0.80 ± 0.02 cm by 0.68 ± 0.07 cm by 0.29± 0.06 mm. The weight and volume of the strips simply decrease by dehydration during hot smoking. As observed by Kohli, [49] we can also notice that during the marinating of meat, the evolution of pH and Aw in the meat causes physicochemical changes which induce the prolongation of the lifespan, the improvement of the sensory quality and the increase of the mass yield. Tenderness is the most important palatability factor in the acceptance of cooked meats [50]. Many factors have been implicated in meat tenderness, including age, breed, sex, fatness, pre-slaughter treatment, dressing, chilling and cooking procedures [51]. Also, many methods of altering meat tenderness have been evaluated. Marination has been used for this purpose for many years. The process has many other positive effects on palatability and shelf life of meat products [52, 53]. Increasing and decreasing the meat pH improves the water-holding capacity by moving the meat pH further from the isoelectric point (about 5.2–5.3 in red meat). As the pH moves further from the isoelectric point, the water-holding capacity increases due to an increase in the amount of negative charges on the meat protein that can bind water [54, 55]

III.4 Nutritional properties of "Charmout"

Broadly taken, the *"Charmout"* is clearly rich in Protein as a meat product. However we can notice (Table V) that *"Charmout"* produce from sirloin seems presenting higher carbohydrate than other *"Charmout"*. The artisanal *"Charmout"* seems also presenting less fat than the one produce at laboratory scale with modified methods.

Table V: Nutritional composition of *"Charmout"*

Productions system	Moisture	Ash	Lipids	Proteins	Carbohydrates
Artisanal *"Charmout"*	4.8±1.5[b]	13.1±0.9[c]	11±1.3[c]	70.2±7.5[a]	5.7±0.8[b]
Sirloin fresh *"Charmout"*	5.9±0.9[a]	8.00±0.5[d]	20±1.7[a]	50±8.8[cd]	22±0.9[a]
Sirloin Maturated 24h at 4° C *"Charmout"*	3.8±0.5[bc]	12.2±0.3[c]	18±1.5[b]	45±3.5[d]	24.8±0.5[a]
Round of heel fresh *"Charmout"*	2.4±0.7[d]	15.4±0.1[b]	15±1.8[bc]	64±6.3[b]	5.6±0.2[b]
Round of heel Maturated 24h at 4 ° C	6.4±0.5[a]	19.7±0.8[a]	23±0.9[a]	52±2.7[cd]	5.3±0.7[b]

Mean values preceded by at least one common letter in the same column are not significantly different ($p < 0.05$) according to the ANOVA and DUNCAN comparison test.

The nutritional composition of dry or smoked meat products can vary between a high content of lipids and high protein value [56, 57]. These variations can be link to a great diversity in the origin of the raw material used and the steps of the processing witch can influence nutrients contents. The variability of nutrition composition observed here in *Charmout* can also be observed in products like rillettes, sausage, and cooked ham [59]. This variations are mainly linked to the raw material and processing as previously demonstrated. *Charmout* meet is a part of local diet with a favorable effect on vitality and incidence of diseases [2, 4, 7]. Composition, physicochemical, nutritional and functional properties, and sensory attributes are comparable with dry and smoked beef [60, 61]. Among all of the analyzed samples, artisanal *Charmout* present the lowest concentration of total lipids (11±1.3g/100 g). In average, *Charmout* meat present low level fat compare to other dry or smoked beef meat [60, 61]. The relatively low fat content in *Charmout* meat can be attributed to poor marbling and the type of muscle use for its production. *Charmout* has less fat and saturated fat than beef [2, 65]. The energy value

for Charmout meat was found to be 57.22% less than beef. Low cholesterol content and energy value (6.8 Kcal/g dry] matter) of Charmout was also reported by Tidjani *et al.* [7]. Palmitic, stearic, oleic, and linoleic acids were reported to be predominant fatty acids in the phospholipids of *Charmout* [60, 61].

III. 6 Microbial quality of Charmout

It is clear from the table below that the artisanal *"Charmout"* is of poor hygienic quality (Table VI). The quality of artisanal Charmout samples are similar to this of other dry meat sold on street in the area like kilishi and pork meat [62, 63]. The presence of fecal coliforms clearly indicates that this poor hygienic quality is due to precarious production conditions. The presence of hygienic indicators germs such as *E.coli*, *Staphylococcus aureus*, Salmonella and Shigella confirm the poor production conditions and clearly establish the link with contamination of human origin [2, 5, 64]. It must also be noted that there is a significant difference between the microbial levels in relation to the type of muscle used as well as the stage of maturation seems to have an influence on the hygienic quality of the final product (Table VI). If we compare this microbiological quality to the production scheme, we can incriminate the steps adding ingredients (seasoning) and steeping as a source of contamination. This critical points should be mastered to improve the hygienic quality of the final product.

Table VI: Microbial profile of "Charmout"

	Artisanal Charmout	Sirloin fresh Charmout	Sirloin Maturated Charmout	Round of heel fresh Charmout	Round of heel Maturated Charmout
Total count (cuf/ml)	$(5.1 \pm 0.1)\ 10^{8b}$	$(5.2 \pm 0.5)\ 10^{5\,a}$	$(6.1 \pm 0.1)\ 10^{6\,b}$	$(5.4 \pm 0.2)\ 10^{5\,b}$	$(4.2 \pm 0.1)\ 10^{4\,b}$
Total coliform (cfu/ml)	$(6.2 \pm 0.3)\ 10^{4b}$	$(3.4 \pm 0.7)\ 10^{4\,a}$	$(4.2 \pm 0.4)\ 10^{2\,b}$	$(1.2 \pm 0.1)\ 10^{5\,b}$	$(1.0 \pm 0.3)\ 10^{4\,b}$
Total thermo tolerant coliforms (cfu/ml)	$(8.2 \pm 0.4)\ 10^{2a}$	$(3.5 \pm 0.4)\ 10^{2\,b}$	$(6.2 \pm 0.3)\ 10^{1\,a}$	$(4.1 \pm 0.2)\ 10^{3\,ac}$	$(2.1 \pm 0.5)\ 10^{2\,ac}$
Staphylococcus aureus	$(2.1 \pm 0.4)\ 10^{2b}$	$(5.5 \pm 0.1)\ 10^{2\,a}$	$(8.7 \pm 0.2)\ 10^{2\,b}$	$(2.1 \pm 0.1)\ 10^{2\,c}$	$(3.1 \pm 0.3)\ 10^{2\,c}$
Streptococcus faecalis (cfu/ml)	$(1.2 \pm 0.0)\ 10^{3c}$	$(7.7 \pm 0.4)\ 10^{3\,a}$	$(2.2 \pm 0.1)\ 10^{2\,c}$	$(2.3 \pm 0.2)\ 10^{3\,b}$	$(2.1 \pm 0.2)\ 10^{4\,b}$
Salmonella and Shigella (cfu/20g)	$(5.1 \pm 0.3)\ 10^{3b}$	$(4.0 \pm 0.2)\ 10^{2\,a}$	$(5.2 \pm 0.5)\ 10^{1\,b}$	$(5.2 \pm 0.3)\ 10^{2\,c}$	$(8.2 \pm 0.5)\ 10^{3\,c}$
sulphite reducing *Clostridia* (cfu/ml)	$(5.0 \pm 0.4)\ 10^{3b}$	$(5.7 \pm 0.3)\ 10^{2\,a}$	$(1.2 \pm 0.1)\ 10^{1\,b}$	$(5.3 \pm 0.4)\ 10^{2\,b}$	$(2.0 \pm 0.6)\ 10^{2\,b}$
Total fungi (cfu/ml)	$(2.5 \pm 0.1)\ 10^{5b}$	$(3.3 \pm 0.7)\ 10^{4\,a}$	$(3.2 \pm 0.0)\ 10^{5\,b}$	$(4.1 \pm 0.1)\ 10^{4\,b}$	$(3.1 \pm 0.2)\ 10^{5\,b}$

Mean values preceded by at least one common letter in the same lines are not significantly different ($p < 0.05$) according to the ANOVA and DUNCAN comparison test

All the *Charmout* samples analyzed confirmed the presence of bacterial pathogens like hygienic test indicators bacteria, indicating the need for strict implementation of food sanitation practices to reduce the possible risk of transmission of infection on consumption of *Charmout*. The presence of these organisms in artisanal *Charmout* should receive particular attention, because their presence indicate public health hazard and give warning signal for the possible occurrence of food borne intoxication. However it can be notice that the "ameliorated *Charmout*" produce by controlling some steps of processing seems lowering the load of different germs found in final product. This imply that the mastering of critical points may affect the quality of the *Charmout*.

III.7 Sensory attributes of "Charmout"

Regarding the awareness and knowledge of *"Charmout"* within the sub region, the interviewed population sample indicate that about 75% of the hole population has already eaten *"Charmout"*.

The sensory evaluation indicate that the most preferred sample is the *"Charmout"* made with *"Sirolin"* maturated muscle with about 37% of hedonic points of interviewed panelist (Fig III). The Same sample of *"Charmout"* made with *"Sirolin"* was found to be the best in taste (30% of hedonic points) and Harmony (Overall acceptability 35%). The aroma and overall appearance criteria seems to be leaded by a commercial dry meat (Bilton) (Fig III).

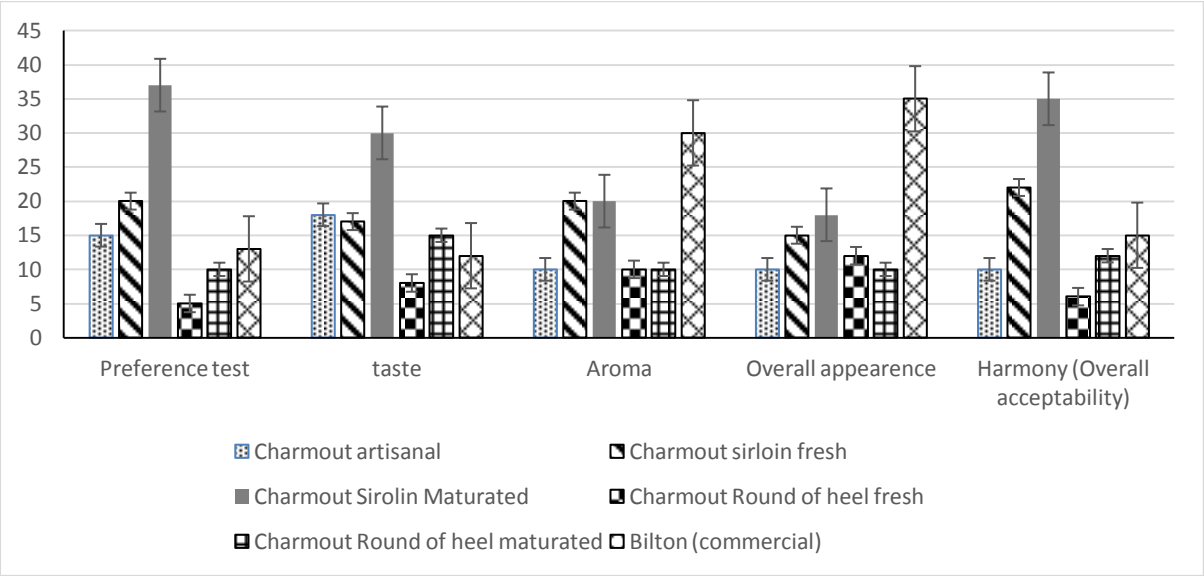

Figure III: Sensorial attributes of *"Charmout"*

We can notice that the "maturated" samples present the best scores taking into account all criteria. This must imply that maturation step may impact sensorial attributes of *"Charmout"*. The maturation phase is by far the most important since it leads to an increase in the tenderness of the meat and the release of organoleptic compounds responsible for the flavor and flavor of the meat [65] (Stahnke, *et al.*, 2002). Maturation is a very complex process mainly affecting the myofibrillar structure and depending on several ante and post mortem factors. It is an essentially enzymatic process [66, 67] (Sentandreu *et al.*, 2002; Herrera-Mendez, *et al.*, 2006). Maturation at temperatures of the order of 0 ° to + 4 C to best preserve the hygienic qualities of the meat. Points of convergence of the two best *"Charmout"*: The *"Charmouts"* that were most appreciated the *"Charmout"* made with *"Sirolin"* maturated muscle. On 6 given assessment criteria, we found 4 criteria where the answers converge and 2 where the answers were found to be divergent while comparing with commercial "Bilton". The points of similarity between the *"Charmout"* made with *"Sirolin"* maturated muscle and that of the commercial "Bilton" are the light color, the pleasant flavor, the crunchiness, the tenderness and the degree of salting. This simply reflects the quality criteria to which consumers are attached and on which we must rely to produce ameliorated *"Charmout"* taking into account only sensorial attributes. These products are described as light brown, beautiful to the eye, with a pleasant flavor, that is to say a good aroma and taste.

IV. CONCLUSION

The objective of this study was to describe the processing of *"Charmout"*, highlight critical points of production, and produce improved *"Charmout"* evaluate its sensorial and hygienic qualities. The artisanal process was clearly describe according to the focus group discussion, the improved production scheme was proposed based on the control of critical points for both sensorial and hygienic qualities. Some physicochemical parameters such as the size of the strips, the evolution of losses, the content of water and the final pH, as well as nutritional properties of artisanal produced *"Charmout"* and laboratory *"Charmout"* were access. This study permitted to characterize the *"Charmout"* production technique and understand the influence of operations and processing throughout the production chain to see the influence. From the technique and production stages to the behavior of the meat, to define the correct size of the pieces of meat in ways to. It turns out that each operation has more or less significant effects on the weight and the organoleptic quality of the final product. The decisive stages in the processing of the *"Charmout"* were the choice of the muscle and its maturation or not, the cutting / peeling of the meat, the marinating of the strips in boiling water and their seasoning, and finally the smoking step. Regarding the choice of muscle, the muscles that were used are the sirloin and the heel ring of the beef carcass. The study of the behavior of the meat or the strips during the cold and hot treatment, allowed us to see that at the exit of the marinade, the pieces of meat gain in volume and lose in weight because there is expulsion of water by evaporation under the action of heat and modification of the structure of the fibers. The losses were also important during the trimming where one recorded 227 ± 132 g and during the cutting where it was 152 ± 51g of meat. These are unwanted losses which reduced the yield in *"Charmout"* to 15 ± 3%. The initial water content of the muscle was 77 ± 2 and that of the *"Charmout"* 20 ± 9% with a maximum of 32% and a minimum of 7%, i.e. a total water loss of 57 ± 10% while the pH of the meat went from 6.8 to 6.3, ie a decrease of 0.3 ± 0.1 which is favorable for conservation. The sensory analysis carried out allowed us in general to observe on the one hand the variability of the *"Charmout"* obtained in terms of the criteria of appreciations of color, flavor,

brittle and crisp aspects, the degree of salt and tenderness and on the other hand the type of *"Charmout*" that consumers prefer.

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