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Conception and development of a new product: canned sardines with red pepper or with Harissa sauce

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Abstract

Tunisian canned sardine enjoys a good brand image and are well appreciated by the consumer world wide. Taking advantage of this fact, we wanted to bring to market two new products: canned sardine in harissa sauce and in red pepper. Thus, 3 CCPs are identified according the Codex Alimentarius. The results showed that the stability is in accordance with the standard. Also, any nonconformity at least about the boxes tested and no spore of *Bacillus* and *Clostridium thermophilics* forms were detected. This result allows us to confirm that our products are stable and that the CCPs are controlled. The percentage of medium recovery is in accordance with the standards and the percentage of water (exudates) does not exceed 8% at the fixed temperatures. Besides, the percentage of water in oil is in accordance with the norms. According to the results, both products meet the various criteria of food safety and the standards required. Finally the Friedman test sensory analysis revealed that the two products are significantly different and sardines with pepper is better appreciated than sardines in Harissa.

Introduction

With an overall production of 100, 000 tons, the fishery sector in Tunisia, represents 17% of the total exports and ranks 2nd after the olive oil. Notably the fishery production has recorded an increase of 3% in the first half of 2012 compared to the same period of 2011 with 54,453 tons against 52,884 tons. The same statistics showed a stable activity of fishing for blue fish with a growth of 5% of the fishing depth and 18% for coastal fishing. Blue fish including sardines, anchovies, tuna, and mackerel, remains the most popular fish in Tunisia. In 2009, stocks were estimated at 119,000 tons including 28% of sardine and 10% of mackerel fish. The exports of canned sardines and anchovies, increased from 650 tons in 2003 to 5, 000 tons in 2009 jointly with the development of the total processing capacity from 70 to 110 tons between 2004 and 2009 (Central Bank of Tunisia, 2013). In recent years, the transformation of this species essentially sardine, have evolved, mainly due to the availability of the raw materials and the strategy of developing the fisheries sector through various mechanism. Motived by the excellent quality of the raw material of Tunisia and listening to new market trends and requirements some operators have begun to enhance the sardine transformation. Thus, new products based on sardines are available on the market combining the taste of this fish with several aromatic components extracted from nautral plants (lemon, rosemary, tea…). Actually, the labelling approach to develop the distinctive quality of Tunisian sardine is being undertaken. In Tunisia, the consumption of sardine in oils or in tomato sauce is a common practice. However, the consumption of sardine in harissa sauce or with hot pepper is not well renowned. Based on this situation, we propose to consumers a new product (Sahli *et al*., 2006).

The aim of this work was to produce canned sardines in harissa sauce and with pepper. The present investigation is a part of research project studying the effects of adding ingredients addition such as harissa and pepper on organoleptic quality of *Sardinella aurita* which is one of the widely distributed fish in Tunisia and represents an important source of low-cost dietary protein.

Materials and Methods

Ingredients of harissa

The Harissa from red pepper was manufactured according to the specification NT 52.07 (2005). In this work, we used the Chili Pepper: *Capsicum Annuum* (Solanaceae). The Harissa Sauce was composed by: 18% of harissa; 55, 97 of water; 25 of Olive oil and 1, 03 of salt. The *Sardinelle aurita* was obtained from the fisheries regional Counter. Each receipt of

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raw materials is accompanied by a safety certificate sheet signed by the Veterinarian. The control of fishery products was made according to the OJTR on 19/09/1998. The sardine's canned products are prepared from fresh fish (Codex Stan 94-1981) and Tunisian standard NT 54.02 (1986).

Microbiological analysis

The Thermophilic *Bacillus* strains are determined according to NF-V08-404 (1986). The Thermophilic *Clostridium* is determined according to NF-V08-405 (1986).

Physico-chemical analysis

The pH was measured using a pH-meter (Metler type) having a control accuracy of ± 0.1 pH units. 9 boxes are randomly collected, where 3 boxes are incubated at 37°C for 7 days, 3 boxes at 55°C for 7 days and 3 boxes are kept at room temperature and are used as controls. For each box the pH found should be equal to 6.0 ±0.5.

The average of the percentage recovery

Firstly, the net weight (NW) of empty boxes and the total weight before opening boxes (total weight (TW)) were determinated in grams. The obtained values of total net weight (TNW) in grams were calculated using the formula:

$$TNW = TW - NW.$$

Before their opening the boxes were cleaned, dried and their label was removed. The sieve of 2.5 mm was placed in the appropriate medium at an angle of 20% (inclination 20%). the content of the box was slowly reversed on the screen. After waiting for 2 minutes, the net drained weight (NDW) was measured. The percentage (%) of weight recovery was calculated using the formula:

$$(NDW/TNW) * 100$$

Finally the percentage (%) of the average weight recovery is calculated.

The percentage of the water

After opening the box and slowly pour the liquid phase in a specimen and waiting for 5 minutes for the clear separation of the 2 phases, the total volume of juice V_1 and the volume of water V_0 will be noted. Then the percentage (%) of water = $(V_0/V_1) * 100$ will be determinated according the formula:

$$\text{Percentage (\%) of water} = (V_0/V_1) * 100$$

Then the average percentage (%) of water will be calculated. We noted that if the percentage (%) of water is ≤ 8% the results are satisfactory.

The sensory analysis

To evaluate the different criteria of final products by the member of jury, we used the methodology described by NF V09-021 (1995): "Search and selection of descriptors for the development of a sensory profile by a multidimensional approach". We proposed to evaluate the intensity of different sensory characteristics using a structured intensity scale with a note ranging from 0 to 5 (Uncollected: 0; Low : 1; Rather low: 2; Medium: 3; Rather strong: 4; and Strong: 5. To obtain an agreement on ratings, training in the use of this scale is recommended. Thus, the members of jury evaluated the reference products before testing the final products.

Results and Discussion

The steps of production of the canned sardines with red pepper or in harissa sauce and the HACCP plan

Increased consumer awareness and new legislative demands on food production systems have resulted in significant efforts in controls measures and assurance systems in different food sectors all over the world (Codex Alimentarius, 2004; Efstratiadis *et al*., 2000; Khatri and Collins, 2007; Ropkins and Beck, 2000). However, various authors indicated that improper food safety management systems (FSMS) contributed to the incidence of food borne diseases worldwide (Motarjemi *et al*., 1996; Summer *et al*., 2004; Luning *et al.*, 2006). Nowadays, various internationally acknowledged and national systems are available for guaranteeing food safety, such as hygiene Codes, HACCP, BRC, SQF and more recently ISO 22000 (Huss *et al*., 2000; Ropkins and Beck, 2003; Da Cruz *et al*., 2006; Neeliah and Goburdhum, 2007). HACCP system has been developed to obtain better food safety. It is a system that builds food safety into products, and then controls the process to ensure the production of safe food. Today, this methodology is internationally accepted as an effective tool to deal with safety hazards which may arise in the food production process. The HACCP system identifies critical control points in the production procedure that are essential to monitor and control product safety where the "Hazard" is defined as a biological, chemical and physical agent in/or property of food that may have an adverse health effect and risk as a function of the probability of an adverse effect and the magnitude of that effect, consequential to a hazard in food (WHO/FNU/FOS, 1995). Fish is one of the most highly perishable food products. Fisheries products have also been recognized as carriers of health hazards such as disease-causing microorganism *Salmonella* spp. and *Vibrio* spp., parasites, natural toxins, heavy metals and others pollutants. In order to assure high quality of canned sardine for consumers,

Table 1. Summary of the of HACCP plan with the significant hazards and CCPs identified

N° CCP	Designation	Dangers	Control measures	Monitoring Parameters	Critical limits
CCP_1	Checking on receipt (the freshness)	Soft flesh and shredded	Rejection of the goods	freshness of the flesh (flesh farm)	< 2% of *Sardinella* (torn skin)
CCP_2	Control of the seams	**Biological** (due to microbial contamination boxes: leakage)	Rejection of the boxes.	* external diameter*height of the empty box * the box thickness (body box), * the height and the thickness of the seams *the end and the body hook, * the overlap	See the guide of the control of the seams. (leaky box <2%)
CCP3	Monitoring of Sterilization	**Biological** (high level of microbial load after sterilization)	monitoring of the scale of the sterilization and stability test (oven)	Temperature Duration Pressure	According to the scale of the sterilization

the HACCP system was applied. The Table 1 reports the HACCP plan, the significant hazard and the CCPs established by the decision tree of the codex Alimentarius (2004). Thus, we identify 3 CCPs where the CCP1 is the control of the freshness of the sardine at the reception (Table 1). The CCP2 is the control of the seams and CCP3 is the monitoring of the sterilization. The CCP1 which concerns the freshness of fish, makes a major contribution to the quality of fish or fishery products and determines the quality of fish as food not only for those to be consumed as raw or used in home cooking but also for those to be processed. Thus, initial quality of raw materials considering their freshness, microbiological load and physical damage, is an important factor which influences the quality of the final product (Fuselli *et al*., 1994). In addition, freshness is essential for the quality of final product. That, at each reception the health surveillance committee control by the regulations set the freshness of sardine especially the firmness (torn skin) of the flesh which is considered as the mainly hazard whose the maximum limit is fixed to 2%. Under these conditions CCP was considered as validated and under control. However, the presence of hydrocarbons is another risk which represents in reality a very small percentage (%). Under these conditions (% of torn skin is > to 2% and/or the presence of traces of hydrocarbons were detected), the control measures according the internal specifications were the rejection of the raw materials and the selection of suppliers made by the notation given to each supplier according to the internal specifications. The CCP2 (control of the seams) is performed regularly to prevent a possible contamination from environment (boxes leaking). CCP was considered as validated, meaning that the hazard was under control where the % of leaky box does not exceed 2% by batch manufacturing according to the internal specifications. The control measure for the CCP2 was the rejection of the boxes. Immediately, where the % exceeded 2%, frequent verifications were made. The auditors look for the probable origins of the case and apply the necessary corrections to reduce the hazard to an acceptable level in order to have a process under control. The CCP3 (sterilization) are monitored and cheeked at regular times. Criteria were established using the parameters recommended for time-temperature in the sterilization scale. The control measure was the control of the scheduled process (time and duration). The hazard is the survival of the spores of *Clostridium botulinum* and *Bacillus thermophilic*. The CCP was considered as validated CCP where no spore exists in the final products. Under these conditions, CCP was considered as a validated CCP.

The validation and verification steps certify that the hazards have been identified and are being controlled, and whether the plan is being conducted as designed (Mayes, 1999; Kvenberg and Schwalm, 2000). Logically, the control of the CCPs is not enough to ensure a high quality for the food product. To be effective, HACCP system needs to be applied from origin to the consumption of the food. Unfortunately, HACCP system meets often difficulties and has a barrier (Bas *et al*., 2006). Practical experience and researches of food safety indicated that success in developing and verifying a successful HACCP system is depending on a complex mix of managerial, organisational (Bas *et al*., 2006); that's why the Tunisian government imposes to agro food industries a training program on the methodology of HACCP and has been establishing the standards legislation and enforcement programs necessary to control food quality and safety. Thus, to ensure high quality of the products, all conditions and measures necessary to ensure the safety and suitability of sardines and sardines products at all the stages of the food chain from the sea to the end of the process are undertaken (internal specifications) and harmonized based on Codex standards guidelines, recommendations and on assessment of risks. This program includes implementation of the HACCP system, food hygienic practices, cleaning and disinfection of premises and equipment, hygiene staff, knowledge of germs, receipt of the raw material and it's assured by the specialists such as veterinarians.

Microbiological analysis

Microbiological quality of the foods is the major concern of food processors and public health authorities. Microbial activity is the main factor limiting the shelf life of fresh fish. For high quality fresh fish, the number of bacteria present on the surface varies from 3 to 4 $\log_{10}$ CFU/g. On gills, counts are normally 1 or 2 orders higher, and intestinal counts can reach 9 $\log_{10}$ CFU/g (Sikorski, 1989). The microbiological indicators are most often used to assess food safety and good manufacturing practices rather than the freshness of products. It has

Table 2. Stability test and pH measurements

Tests Conducted	Samples for 7 days								
	Room temperature			37ºC			55ºC		
	box_1	box_2	Box_3	box_1	box_2	box_3	box_1	box_2	box_3
pH before	6,25	6,10	6,20	6,30	6,50	6,32	625	6,20	6,15
pH after	6,28	6,30	6,34	6,23	6,23	6,21	6,25	6,28	6,30
notice	stable	stable	stable	stable	stable	stable	stable	stable	stable

Table 3. The percentage of recovery medium

Properties	Room temperature			37ºC			55ºC		
	box_1	box_2	box_3	box_1	box_2	box_3	box_1	box_2	box_3
TNW	128	126	127	127	125	126	129	123	127
NDW	105	102	98	97	84	85	97	89	95
(NDW/TNW)	82	81	77	76	76	67.5	75	72	75

been reported by Jayasinghe and Rajakaruna (2005) that the number and the nature of bacteria on fish are affected by many factors such as method of capture, handling practices. They proved that 40% of the investigated fish samples had fecal coliform counts 10^2/g, while 35% contained counts < 50/g. Most of the samples contained *E. coli* counts > 10/g while 16.6% of the fish samples were with counts >10^3/g. The considerably high count of coliform and *E. coli* recorded indicates high contamination of fish.

Thus, the goal of the HACCP system should be to reduce the risk of food borne illness to the consumer. In this study, the microbilogical quality of canned sardines by the analysis the spore forms of Bacillus and *Clostridium thermophilics* was evaluated and we focused especially on spore's forms which are known for their heat resistance. The results showed the absence of the spores which may indicate that the CCP3 (the sterilization) is controlled. Besides, it could be noticed that the good hygienic practices (GHP) (no contamination) are applied. Normally, according to the microbiological indicator, we proved that the GMP and the safety of products are provided and that the products are free of biohazards and is suitable for consumption.

The Stability test and pH measurements

Accordingly, the quality of processed fish will depend to a large extent on the adequacy of the preliminary holding methods used (Aubourg and Medina, 1997). Thus, the stability control of the final product is an essential element of procedures verification that operators must establish to implement the actions described in HACCP system and in guidelines such as internal specifications. The sampling plan is predetermined taking into account confidence in the process control and depending on the estimated risks. In practice, the incubation test I is a good indicator of mastery of the process. In literature, pH value has been employed often as a complementary analysis to fish spoilage detection. The results of stability test and pH measurements are reported in Table 2. The obtained results showed that the pH is ranging between 5.5 and 6.5 for all tests at various temperatures. These results are in agreement with those obtained by Huss (1995) which proved that the pH of fresh fish muscle tissue is close to neutrality, and of those of Kilinc and Cakli (2004) which showed that the pH of fresh fish is often between 6.0 and 6.5 and that the pH depend on fish species and others factors. Yet, we noted that no box is convex and no leaking or floss boxes. In this study, according to the obtained results, pH is stable. However, boxes of canned sardines in harissa sauce or with pepper are stable at the tested temperatures t and the pH values ranged between 5.5 and 6.5 which are in agreement with the standard NF-V 08-401 (1997).

Table 4. The percentage of the water

Properties	Room temperature			37ºC			55ºC		
	box_1	box_2	box_3	box_1	box_2	box_3	box_1	box_2	box_3
$V_{0\,(eau)}$	1	1	1,5	1	1	1	1,5	1,5	1,5
$V_{1(Total)}$	100	100	101	100	100	100	102	102	101
$(V_0/V_1)*100$	1%	1%	1,4%	1	1	1	1,5	1,5%	1,5

Table 5. Sensory analysis

	box_1 Sardines with chilli		box_2 Sardines with chilli		box_3 Sardines with harissa		box_4 Sardines with harissa	
Jury	Note	rank	note	rank	note	rank	note	rank
A	10	1	9	2	8	3	9	2
B	10	1	10	1	9	2	8	3
C	10	1	9	2	9	2	8	3
D	10	1	10	1	8	3	9	2
E	10	1	9	2	8	3	8	3
F	10	1	10	1	9	2	8	3
Average	10		9,5		8,5		7,66	
Rank	1st		2nd		3rd		4th	
∑r		6		9		15		16

The percentage of recovery medium

The Table 3 reports the results of the percentage of recovery medium. The obtained results showed that the percentage of recovery medium ranged between 67.5% and 82% at all used temperatures. These results are in accordance with the Regulation (EEC) No 2136/89 of the council of June, 21, 1989. However, the Article 7 which announced that Without prejudice to Directives 79/112/EEC and 76/211/EEC, a trade description on pre-packaged canned sardines is determined by the ratio between the weight of sardines contained in the container after sterilization and the net weight, expressed in grams. For the presentations referred in Article 4, this report is at least equal to the values of 70% for packing media referred in Article 5.

The percentage of the water

Table 4 reports the percentage of water. The obtained results showed that the percentage of water ranged between 1% and 1.5% at all used temperatures. Similar results were obtained by Losada *et al*. (2007) which proved that the water of canned sardine ranged 1.1–1.9%. These obtained percentages of water in oil do not exceed 8% and they are in accordance with the Regulation (EEC) No 2136/89 of the council of June, 21, 1989. However, the Article 6 which announced

that the product in the container, as they occur after application of the sterilization process must at least satisfy the following criteria: as regards the packing medium, having a color and consistency characteristic of its name and ingredients used. In the case of hedge oil, it can not contain aqueous exudates in excess of 8% of net weight.

The sensory analysis

Sensory evaluation is the most important method for freshness and quality assessment in the fish sector (Hootman, 1992). Sensory inspection of processed fish used in the fish industry to find defects that have occurred during handling and processing (Oehlenschlanger, 1998). The various sensory characteristics, such as outer, appearance, odour and colour are still very important in the quality system in fish processing industry. Sensory methods are fast, simple, sensitive and objective but they rely on human judgement and proper training of panels (Sims *et al.*, 1992; Strachan and Nicholson, 1992). Sometimes sensory tests are also perceived to be inherently subjective (Krzymien and Elias, 1990). In this study, the sensory assessment of final products, sardines in harissa sauce and sardine with pepper, was conducted using the sensory attribute especially the hot taste using the methodology described by Dominique (2000) with a panel of trained panellist (Table 5). The hot taste (pungency) is the mainly required taste by consumers in this kind of product. Previously, the judges evaluated the reference products and after this we discussed with them to obtain an agreement on ratings. Thus four boxes are randomly collected where the average weigh is between 78 g and 100 g. Each box contains 6 sardines. Fish samples from the different treatments were individually presented in covered small porcelain dishes to each panellist. The member of the jury giving their evaluation points on the criteria (hot taste) of the final product. Statistically we compare the products by Friedman *et al.* (1980) test. The Friedman test is a non-parametric test for analyzing randomized complete block designs. The Friedman test (F) is a test for comparing three or more related samples.

The Friedman test F was calculated according to the following formula:

$$F = \frac{12\,[R_1^2 + R_2^2 + \ldots + R_p^2]}{n^*p\,(p-1)} - 3n\,(p+1)$$

Where n : number of subjects (n = 6), p: number of products (p = 4), R : rank

$$F = 12^*((6)\,2 + (9)\,2 + (16)\,2 + (15)\,2)/6^*4^*3) - 3^*6^*5$$
$$\text{donc } F = (7176/72) - 90 = 9{,}66$$

$$F = 9{,}66 > F_{th}\,(7{,}81).$$

The critical value at 5% is $F_{th} = 7.81$ determined from χ^2 to (p-1) degrees of freedom. Thus, we noted that calculated F is greater than F_{th} ($F = 9{,}66 > F_{th}$ 7,81). Therefore, the products are perceived as being significantly different at 5%. The treatment effects have no identical effects. Probably, the salt (salty taste of the harissa) and the oil (diminishing of the hot taste of the harissa) obscure the real taste of the product (sardines in harissa sauce). Besides, according to the assessors, sardines with pepper are more aromatics than sardines in harissa sauce, and sardines with pepper is ranked first and second for their tastes and for their appetites. However, the sardines in harissa sauce are ranked third and four.

Conclusion

Tunisian canned sardine enjoys a good brand image and are well appreciated by the consumer world wide. Taking advantage of this fact, we wanted to produce two new products: canned sardine in harissa sauce and canned sardine in red pepper. Thus, 3 CCPs are identified according to the Codex Alimentarius. These CCPs are monitored and audited on regular times. According to the results, the test of stability is in accordance with the standard. Also, we did not notice any major non conformity at least about the boxes tested and no spore of *Bacillus* and *Clostridium thermophilics* forms were detected. In the first hand, this result allows us to confirm that the tested products are stables and that the CCPs are mastered. On the other hand, the % of medium recovery and the % of water in oil are in accordance with "CEE" n° 2136/92 and the % of water (exudates) does not exceed 8% at the used temperatures. In addition, It was shown that both products meet the various criteria of food safety and the standards required. Finally the sensory analysis showed that the two products are significantly different and sardines with pepper is better appreciated than sardines in Harissa.

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