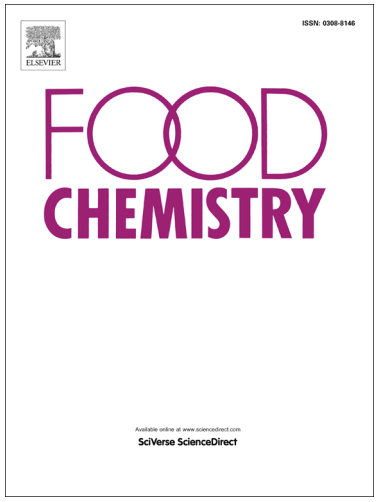

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CONSUMER ACCEPTANCE AND SENSORY PROFILING OF REENGINEERED KITOZA PRODUCTS

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Running title –

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Abstract

Kitoza refers to a traditional way of preparing beef and pork in Madagascar. However, in order to improve some drawbacks previous identified, the product was submitted to a reengineering process. The acceptance and sensory profiling of improved Kitoza products among Portuguese consumers was investigated. A local smoked loin sausage was selected as basis for comparison. Firstly, a Focus Group study was performed to identify sensory descriptors for Kitoza products and explore product perception. Subsequently, a Flash Profile and a consumer sensory acceptance study were conducted. Flash Profile's results showed that beef- and pork-based Kitoza products investigated differed considerably in all sensory dimensions. The Portuguese sausage was characterized as having a more intense and lasting after taste, as well as displaying a higher degree of (meat) doneness. The acceptance study yielded higher overall liking ratings for pork- than for beef-based Kitoza, although the Portuguese sausage remained the most appreciated product.

Keywords: Kitoza, smoked/dried meat, beef, pork, Madagascar, sensory profile, consumer test.

1. Introduction

Kitoza is a traditional product of Madagascar made from lean beef or pork meat. It was consumed for a long time ago by royalty and the wealthy has been popularized in this country over time. It is nowadays highly appreciated by Malagasy people of different social classes and also by foreigners, being mainly eaten with rice in soups at either breakfast or dinner times.

Kitoza is mainly prepared from meat from the hump of Malagasy zebus or Zebus, although pork meat can be also used. It is locally sold in many different forms: raw in butcheries, cooked in street eateries, dried and smoked in supermarkets.

Kitoza is traditionally prepared by trimming and slicing the meat into approximately 2–4 cm thick and 20 to 50 cm long strips, which are then uniformly salted. Depending on the preference, spices such as garlic, pepper and ginger may also be added to enhance the taste and tenderize the meat. The strips are then threaded onto a cord and hung over fire (a fireplace or barbecue), in order to smoke for at least 24 h. In butcheries, Kitoza is hung on a cord and then air dried at room temperature.

Meat preservation processes are based on slowing down or inhibiting different microbiological, enzymatic and chemical alteration processes (Sciences et Societé, UNESCO, 1986; Touzi & Merzaia-Blama, 2008). Most meat-based products are obtained through a combination of meat preservation processes such as drying, salting, smoking, frying or fermentation which are inexpensive process and widely used in these countries (Kalilou, 1997, Yacouba, 2010).

Applying meat preservation conditions in these countries is a very difficult task, due to a lack of adequate cold storage infrastructure, and especially, owing to climate and environmental conditions that precipitate the rapid degradation of this product. In

Madagascar, due to the highly perishable nature of meat, this type of foodstuff is often dried and/or smoked because the preservation process is easy and economically viable. There are two main advantages related to processing meat through drying:

1) To reduce the water activity in the processed product, thereby inhibiting the development of microorganisms and the rate of enzymatic reactions;

2) To reduce the weight and volume of the final product, thus facilitating its preservation during transport and storage (Yacouba, 2010).

Although being widely consumed in several African countries, traditional Kitoza production does not meet EU food safety requirements and cannot be exported to Europe. However, Kitoza has a high organoleptic potential and its production could be improved to meet international standards.

In the framework of an FP7 project – AFTER "African Food Tradition rEvisited by Research", a reengineering process based on the reorganization of traditional one was conducted to develop Kitoza products adapted to the European market with regard to their safety as well as consumer acceptability. To this end, two studies were done. A consumer study was held to investigate acceptance and drivers of preference and choice among Portuguese consumers in the EU, in which overall liking, intensity of sensory attributes in relation to participants' ideal level, price and placement were evaluated (Gaze et al., 2015). A complementary study on sensory characterization of the products by means of a sensory descriptive study performed with experienced panellists using the Flash Profile method (FP). FP is part of the faster and more flexible novel methodologies for sensory characterization that have been developed in the last years, to overcame some of the constraints of time and resources of conventional descriptive analyses (Cruz et al., 2013; Kim, Jombart, Valentin, & Kim, 2013; Valentin, Chollet, Lelièvre, & Abdi, 2012; Varela & Ares, 2012). Not requiring specific training of

panellists, FP was suggested by Dairou and Sieffermann (2002), for sensory description of food products according to their most salient sensory attributes. Since then it has been applied to describe many different foods including fruit products and beverages, having been proved to be as satisfactory as conventional profiling in many applications, using either trained or semi-trained panellist or consumer panels (Delarue, 2014; Delarue & Sieffermann, 2004; Moussaoui & Varela, 2010; Valentin, Chollet, Lelièvre, & Abdi, 2012; Varela & Ares, 2012). In view of this, the main objective of this study was to investigate the acceptance and sensory profiling of improved Kitoza products among Portuguese consumers.

2. Materials and methods

2.1. Samples

The Kitoza samples (beef and pork) for sensory and consumer tests were prepared using French meat (due to restrictions to export meat from Madagascar).

These samples were obtained through a reengineering process of the Kitoza products by Institut technique Agro-Industriel des filières viandes (ADIV) platform (CE approved) in France under support of traditional knowledge of Madagascar; according to an improved protocol developed in the framework of an international collaborative FP7 project funded by European Union “African Food Tradition rEvisited by Research” (AFTER).

The optimization approach resulted in the final protocol (Figure 1). At the food processing facilities in CIRAD, Montpellier, France, the meat was cut in strips (2 cm x 30 cm). Then pork meat was seasoned with NaCl (18 g/kg), $NaNO_2$ (0.11g/kg), KNO_3 (0.15 g/kg), garlic (4 g/kg), four spices mix (pepper, cloves, nutmeg, cinnamon, 2 g/kg)

and inoculated with the bioprotective cultures (B-LC-77, CHR HANSEN) composed of a mixture of *Pediococcus acidilactici* and *Staphylococcus carnosus*. It is specially developed for application in meat products to secure the formation of curing flavour and stable colour and to inhibit *Listeria monocytogenes.* Our preliminary data showed the interest of the application of these bioprotective cultures on these kinds of products (data not shown). The product was then smoked and dried at 60 °C, 0% of hygrometry during 95 min. Beef meat was seasoned with NaCl (18 g/kg), ginger powder (5 g/kg), sunflower oil (41g/kg) and inoculated with the bioprotective cultures (B-LC-77). The product was then smoked and dried at 60 °C, 0% of hygrometry during 65 min.

The Kitoza meat samples were vacuum packaged and shipped to Portugal under refrigerated (4°C) conditions for the Portuguese sensory and consumer's tests. In parallel microbial analyses were carried out.

Since Kitoza is an unknown product for Portuguese consumers, a local smoked loin sausage was selected as basis for comparison. This sausage loin smoked sausage is a commercial product sold by Primor (Portugal). The product is made from pork and is marketed in vacuum packages (350 g) in refrigerated conditions (0 ºC-5 °C) and a shelf life of 90 days.

The Kitoza meat samples processed and smoked loin sausage are represented in Figure 2: (1) Kitoza beef (KB), (2) Kitoza pork (KP) and (3) Traditional Portuguese smoked loin sausage (PS). The three different samples were used for Portuguese sensory and consumer's tests. Samples were served to the panellists at room temperature in the form of thin slices of approximately 0.5 to 1 cm thickness, without further preparation. Good hygiene practice was followed.

164 **2.2.Microbial analyses**

165

166 Kitoza manufactured samples (beef and pork) were evaluated in terms of food safety
167 and hygiene of the process. Microbiological samples were taken and analysed on
168 selective media according to the Standard methods of microbiological food analysis and
169 the ISO (International Organization for Standardization) Standard (Table 1). The total
170 counts were numerated on Plate Count Agar at 30°C for 72 h; yeasts and moulds on
171 Yeast Glucose Chloramphenicol Agar at 25°C for 48 h; coagulase negative
172 staphylococci on Manitol Salt Agar at 30°C for 48 h; and lactic acid bacteria on Man,
173 Rogosa and Sharpe Agar at 30°C for 48-72 h under anaerobic conditions. The
174 *Enterobacteriaceae* were numerated on Violet Red Bile Glucose Agar at 37°C for 24 h;
175 *Staphylococcus aureus* and coagulase positive staphylococci on Baird-Parker Agar
176 37°C for 24-48 h. *Listeria monocytogenes* and *Salmonella* were detected after
177 enrichment step according the ISO standard (Table 1).

178

179 **2.3. Ethical assessment and consent**

180

181 These studies have been assessed and approved by the Natural Resources Institute
182 (NRI) (Kent, United Kingdom) Ethics Committee. Informed consent was signed by
183 sensory panellists and consumers who participated in this study.
184 Participants were informed prior to the study that their participation was entirely
185 voluntary, that they could stop the interview at any point/time and that their responses
186 would remain anonymous.

187

188

2.4. Flash Profile

The sensory profiling study was conducted at the Escola Superior de Biotecnologia – UCP, Porto in Portugal. To this end, samples of the three products were rated by 18 sensory panellists using Flash Profile (FP) (Dairou and Sieffermann, 2002). This is an alternative sensory analysis technique, adapted from free-choice profiling, which is employed to understand the sensory positioning of products (Garruti, Facundo, Lima & Aquino, 2012). This technique combines vocabulary generation through free choice profiling by individual panellists with attribute intensity ranking. FP is usually done in two sessions or steps. In the first session/step panellists are asked to evaluate samples comparatively in order to generate descriptors they consider appropriate to discriminate between the samples. In the second, panellists rank all samples for each selected attribute (Varela & Ares, 2012).

The panellists were recruited and selected in compliance with ISO Standard 8586:2012 (ISO, 2012a) and completed a 3-month training period on sensory evaluation. Training focused on language development, improvement of discriminating ability, memorization and rating intensities of selected attributes. Panel performance was evaluated at the end in compliance with ISO 11132:2012 (ISO, 2012b).

Sessions were conducted in a sensory laboratory with controlled air temperature and lightning. The facilities complied with the requirements of ISO 8589 (ISO, 2007) and comprised a training room, dedicated kitchen and sensory booths with computerized data collection.

In the beginning of the first session, the panellists were briefed about the FP procedure and asked to evaluate the three samples in order to generate sensory descriptors to differentiate among them. The records for attributes definition are represented in Table

2. At the end of the session, descriptors were compiled along with the correspondent anchors, synonyms discarded. The pooled attribute list of 23 descriptors is presented in Table 3. In the second session, panellists were instructed to choose whichever descriptors they would consider more adequate (from the pooled list or others) and to rank the intensities in all samples using a continuous graphical scale (0 to 10). These were allowed and panellists could re-taste the samples as much as they liked (Lawless & Heymann, 2010). Samples in both sessions were presented coded with random three digit codes, water was provided for mouth rinsing.

2.5. Focus groups

In order to gain insights on consumer´s perception towards Kitoza meats, one small focus group discussion was performed in Porto (Portugal) with nine recruited volunteers (four men and five women) of different ages. The individuals were invited to taste the two Kitoza products, and to give their impressions about them, main product attributes, possible motivations to buy and to consume, the circumstances and locations for consumption.

The focus group was led by an experienced moderator. A focus group script was developed based on the proposed aims. The themes exploited in focus groups are presented in Table 4.

2.6. Consumer acceptance

The study was conducted at Escola Superior de Biotecnologia (ESB) – Universidade Católica Portuguesa (UCP). Participants were non-probabilistically recruited (Porto, n=94) according to their willingness and availability to participate in the study. Their

ages ranged between 18 and 55 years old (average 29), 99% were European residents. 22% of participants consumed different types of charcuterie on a daily basis, 65% of participants consumed these products at least once a week and 9% at least once a month, 4% of participants only consumed these products occasionally.

Questionnaires were administered using Qualtrics (Qualtrics, LLC), an online survey software. Sample acceptability was assessed by overall liking, aspect, texture, flavour ratings provided on a 9-point verbal hedonic scale. (1 = "dislike extremely, 5="neither like nor dislike", 9 = "like extremely") (Jones, Peryam & Thurstone, 1955; Peryam & Girardot, 1952; Peryam & Pilgrim, 1957; Gaze et al., 2015). Hierarchical cluster analysis (Euclidean distances and Ward's agglomeration method) was subsequently performed to identify groups of participants with dissimilar patterns of sample liking.

Sensory attributes – slice size, slice thickness, smoked flavour and condiment, relative to participants' ideal level were measured by attribute ratings provided on a 7-point just-about-right scale [1-3 *too weak* (TW), 4 *just-about-right* (JAR), 5-7 *too strong* (TS)]. The just-about-right (**JAR**) scale combines assessment of attribute intensity and hedonic evaluation, providing information on how consumers feel about a product and how much a sample deviates from an ideal point (just-about-right) (Gacula, Rutenbeck, Pollack, Ressurection, & Moskowitz, 2007; Morais, Morais, Cruz, & Bolini, 2014; Paixão, Rodrigues, Esmerino, Cruz , & Bolini, 2014; Esmerino, Cruz, Pereira, Rodrigues, Faria, & Bolini, 2013; Popper, 2014).

To evaluate the potential impact of the geographic origin of Kitoza on consumer demand, the survey contained a question asking participants how much they were willing to pay for the Kitoza products they had just sampled. Half of the participants were informed about the Malagasy origin of the recipe while the other half were not. The surveys containing the two versions of this question were randomly distributed

among participants. Finally, the survey also included questions about the appropriateness of eating/buying situations for the sampled Kitoza products.

2.7 Statistical analysis

XLSTAT software (Addinsoft SARL, France) was used to carry out the statistical analyses. The significance of statistical tests was evaluated at $p<0.05$, unless otherwise mentioned.

The FP results were analysed using General Procrustes Analysis (GPA) a multivariate statistical technique. GPA reduces the scale usage effects by detecting and minimizing individual differences and delivers a consensus configuration and allows the comparison of the proximity between terms that are used by different assessors to describe the test samples (Næs, Brockhoff & Tomic, 2010; Hernández-Carrión, Varela, Hernando, Fiszman, & Quiles, 2014; Rodrigues & Teixeira, 2013; Santos et al., 2013)

Analysis of Variance (ANOVA) was performed on within-clusters' overall liking ratings (aspect, texture and taste) for the three samples, considering participants and samples as sources of variation. Within-cluster mean sample ratings were calculated and significant differences between them tested post-hoc using Tukey's HSD (Honest Significant Difference) tests. Pair-wise Pearson correlations between samples' overall liking ratings were then computed to assess their degree of association.

Hierarchical cluster analysis (Euclidean distances and complete Ward's agglomeration method) was subsequently performed to identify groups of participants with dissimilar patterns of sample liking. The frequency of intensity ratings (TW/TL, JAR, TS/TL) for each of the four sensory attributes evaluated by participants was determined for each sample, and the corresponding proportions calculated.

3. Results and discussion

3.1 Microbial evaluation

First the results highlighted the absence of pathogenic bacteria such as *Salmonella* and *Listeria monocytogenes* and the count of *Staphylococcus aureus* was below to the detection level in the two Kitoza samples (Table 1). Yeasts and moulds and *Enterobacteriaceae* were enumerated at low level attesting of the hygienic quality of the meat products. The count of the lactic acid bacteria and coagulase negative staphylococci were approximately 7 and 6 log CFU/g, respectively. As expected, these counts are in accordance with the inoculation level of the bioprotective cultures.

3.2 Flash profile

Flash profile was chosen as a satisfactory method to describe the sensory profile as an alternative to the use of the Quantitative Descriptive Analysis (QDA), since QDA involves several sessions to generate the descriptors and extensive training with the panel working with the references. Moreover, we had short time between the arrival of samples from France and their shelf life. However, we are aware that this method did not generate data with the same degree of reliability (Cadena, Cruz, Netto, Castro, Faria, & Bolini, 2013), but possess enough discrimination capacity for these samples. The results of GPA performed on the FP evaluation of the three samples are presented in Figure 3. The first two dimensions of the GPA analysis accounted for by 76.5% and 23.5% of the variance respectively.

A good discrimination between the three products was observed. KB was described as having a darker colour tone (doneness) on the outside, but a rawer aspect inside, as well as an intense meat flavour. KB contrasted with PS in terms of the attributes saltiness, moisture, cooking texture, spices, and succulence. These were all relatively stronger for KB and weaker for PS, while aftertaste intensity and duration were stronger for PS than KB. KP main attributes were a more intense smoked odour and flavour, sweet and spiced odour, with a more fibrous and elastic texture, than the other two samples.

3.3. Focus groups

The participants observed both Kitoza samples and made some considerations as respect that sensory attributes. The main reactions on Kitoza products by the Portuguese consumers who participated in focus groups were as follows:

- KP was defined as aromatic, sweet taste and similar to a traditional Portuguese smoked loin sausage.
- KB was defined as smoked odor, undercooked meat, poor consistency, very smooth and floury.
- Overall agreed that the samples had different textures. KP much drier and KB with more moisture content and undercooked meat aspect.
- The majority considered the products belonging to the category of smoked meat sausages food and dry meat. With respect to KP, they considered that it had similarities with traditional Portuguese products (like “salpicão”, but without the tripe, or smoked loin sausage), the sweetest and much less salty than similar Portuguese products and with a spicy taste (curry, coconut, cinnamon). Participants considered the KB to be quite different and could not identify in the

national markets similar smoked products; however they indicated some similarities with roast beef.

- Concerning the occasion of consumption, they showed that they would consume only on special occasions, as for example before the dinner with delicacies or how as a snack in a party.
- They consume KP “just like” or probably used in duck rice or mixed with pasta. They probably consume KB only cooked (maybe grilled). For the purchase of these products, KP would be the product they buy most easily because it had a more appealing aspect, while the KB did not have a very attractive appearance. However, the way they are marketed could influence the purchase. The type of market that considered ideal for the sale of these products was the delicatessens, gourmet shops or supermarkets.
- They considered that would it would be useful to have knowledge about the origin of the products; they would buy this product more readily if in the label was written "product manufactured in Europe - according to the traditional recipe of Madagascar".
- Even though they have not considered very attractive products, in short they considered that KP was similar to some traditional Portuguese products, and it was more familiar, tastier and more artificial. They rated “just like” this product. KB was considered different from traditional Portuguese products since the Portuguese’s people do not customarily consume meat products produced from beef meat. They highlighted the unattractive aspect, but nevertheless this product ended up generating more curiosity. They described the product with floury and friable texture and they would consume this type of product cooked.

364 ### 3.4.Consumer study

365

366 #### 3.4.1 Overall liking scores

367

368 The overall acceptability of all samples significantly differed between the three samples
369 at a significant level of $p \leq 0.01$ (one-way ANOVA) (Table 5).
370 On average, all samples were positively appreciated since the mean scores of overall
371 liking were above 5.5. PS was the most preferred product (7.223±0.135) followed by
372 KP (6.319± 0.166) and KB (5.606±0.229), which obtained the lowest mean rating.

373

374 #### 3.4.2 Hierarchical cluster analysis

375

376 The hierarchical cluster analysis (Ward method) identified three groups of consumers
377 with different overall liking patterns as depicted in Figures 4: Cluster 1 (**C1)** - *Kitoza*
378 *beef dislikers* (41%), Cluster 2 (**C2)** - *Overall likers* (43%) and (Cluster 3) **C3** - *Kitoza*
379 *pork dislikers* (16%) (Figure 5). Kitoza pork was liked by 84% of participants (clusters
380 C1 and C2), whereas Kitoza beef was liked by 59% of participants (clusters C2 and C3).
381 Consumer acceptance was positive for all samples, but differed significantly between
382 them ($p < 0.05$). Mean overall liking ratings showed that PS was better appreciated than
383 KP and KB.
384 Positive significant correlations were observed between overall liking and acceptance of
385 sensory attributes, aspect, texture and flavour by consumers (Table 5). Correlations
386 between sensory attributes were also similar for the different clusters.

387

3.4.3 Evaluation of intensity of sensory attributes relatively to participants' ideal level

Figure 6 shows the frequencies of intensity ratings, measured on a 5-point JAR scale, for each Kitoza sample and Traditional Portuguese smoked loin sausage and sensory attributes evaluated.

A preponderance of JAR (Just-About-Right) ratings was observed for PS for the four attributes evaluated, with their frequencies ranging from 53.2% to 86.2%. This is well in line with overall liking results, which showed that PS was the preferred sample for Portuguese consumers.

For KP, TW/TL (Too weak/Too little) ratings dominated the smoked flavour and slice size. For condiments and slice thickness the frequencies of JAR ratings were 35.1% and 51.1%, however condiments obtained similar ratings for TW/TL, JAR and TS/TL (Too strong/Too large), with values of 34.0, 35.1 and 30.9%, respectively.

For KB, with TW/TL ratings being preponderant for most attributes except for slice thickness; slices size obtained 67.0% for TW/TL ratings, which shows that most participants preferred larger slices. This result is also in line with the overall taste results, which showed that KB was the least preferred sample.

The results of the JAR highlighted that KB and KP should have larger slices size and stronger smoked flavour.

3.4.4. Willingness to pay and product placement

Information about Malagasy traditional origin of Kitoza products had a positive impact on participants' willingness to pay, both for KP and KB (Figure 7). On average,

413 participants stated they were willing to pay a significant higher price pay for KB and KP
414 (respectively 3.3 € and 3.2 € for 100g of product) than when they were not informed
415 about the origin of the products (2.2 € for 100g of both products). These results could
416 be related to the unusual and exotic character associated with tradition Malagasy
417 traditional origin.

418 Figure 8, shows the results concerning tasting occasions of KB and KP. The results
419 were similar for both Kitoza products, being the main consumption preference as
420 appetizer for KB (33%) and KP (30%) and as snack, KB (32%) and KP (29%).
421 These results show the trend of consumer's preference in terms of tasting which
422 resembles to the form of consumption of traditional Portuguese charcuterie products.
423 In relation to product placement participants considered the supermarket charcuterie
424 sections the more appropriate place to sell Kitoza products (Kitoza beef (32%) and
425 Kitoza pork (37%)), followed by supermarket gourmet sections (Kitoza beef (22%) and
426 Kitoza pork (21%)). Similar results were obtained for both Kitoza samples (Figure 9).
427 Tasting occasions and product placement for Kitoze products resembles the same trends
428 of traditional Portuguese charcuterie products.
429 These results suggest that because the participants were unfamiliar with this kind of
430 products, they chose market for the sale of Kitoza that were the similar market where
431 similar Portuguese products would be vended, namely supermarkets charcuterie
432 sections. The gourmet shops were other major choices probably because consumers
433 consider these products to be exotic or delicatessen.
434
435
436

4. Conclusions

Sensory evaluation resulted in 23 attributes to describe the sensory characteristics of the meat samples. Among the main results we can highlight that the sensory evaluation of meat samples revealed different sensory profiles. The major differences found were that KB was more related to thickness, meat flavour and colour tone aspect attributes and had a more intense meat flavour. KP showed more intense sweet odour, spices and smoked odour. On the other hand, PS was related to after taste duration and intensity sensory attributes.

Between the two Kitoza samples, KP was the most appreciated, although the PS used for comparison in this study was the most appreciated overall, as expected. It is hypothesized that these results are due to the fact that Kitoza products are unknown for most Portuguese consumers and that most of dried and cured meat products are made of pork meat in Portugal.

The appropriateness of spicy flavour, smoked flavour and slice size evaluated showed that most consumers would prefer larger product slices, while in the case of Traditional Portuguese smoked loin sausage although it was presented in small pieces, as it is a more familiar product the slices size was considered JAR by 86.2% of participants.

The impact of Madagascar traditional origin of the recipe evaluated showed a positive effect on product preference, since a significant increase was observed in the average price the consumers stated they were willing to pay, both for Kitoza beef and Kitoza pork, because participants associated with these products exotic products, valuing them.

Moreover, the employment of overall liking assessments and JAR technique and uncovered important drivers for further sensory optimization of the Kitoza samples improved through reengineering processes.

Although the Kitoza products are unfamiliar to most of the Portuguese consumers, the results of this study revealed that improved Kitoza products have the potential to be well accepted and to be promoted and introduced in Portugal and other European markets. This also has the potential to contribute to improved incomes and livelihoods for people living in Madagascar.

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642 **Captions for figures:**

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644 **Figure 1 –** The diagram of reengineered process of Kitoza in Europe.

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646 **Figure 2 -** Kitoza samples and traditional Portuguese smoked loin sausage. **A** - Kitoza beef (KB); **B** -
647 Kitoza pork (KP); **C**- Traditional Portuguese smoked loin sausage (PS) used for comparison.
648
649 **Figure 3** – General Procrustes Analysis (GPA) representation of Flash Profile (FP) data (representation of
650 FP sensory attributes of Kitoza samples and Portuguese sausage). **KB** - Kitoza beef; **KP** - Kitoza pork;
651 **PS** - Traditional Portuguese smoked loin sausage.
652
653 **Figure 4** – Hierarchical clustering dendogram that segments participants according to their overall liking
654 patterns of Kitoza samples and Portuguese sausage (n=94).
655
656 **Figure 5** – Mean consumer acceptance of Kitoza samples and Portuguese sausage. Kitoza beef (KB),
657 Kitoza pork (KP) and Traditional Portuguese smoked loin sausage (PS).
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659 **Figure 6** – JAR evaluations (%) for Kitoza samples and Portuguese sausage. Kitoza beef (KB), Kitoza
660 pork (KP) and Traditional Portuguese smoked loin sausage (PS).
661
662 **Figure 7** – Mean prices that consumers stated they were willing to pay for 100g of Kitoza beef (KB) and
663 Kitoza pork (KP), with and without information about the recipe (Malagasy traditional origin). Error bars
664 represent the confidence interval of the mean (p=0.95).
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666 **Figure 8** - Preferred ways of consuming Kitoza beef (KB) and Kitoza pork (KP).
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668 **Figure 9** - Shops that Portuguese consumers considered appropriate for the sale of Kitoza beef (KB) and
669 Kitoza pork (KP).
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677 **Figure 1:**
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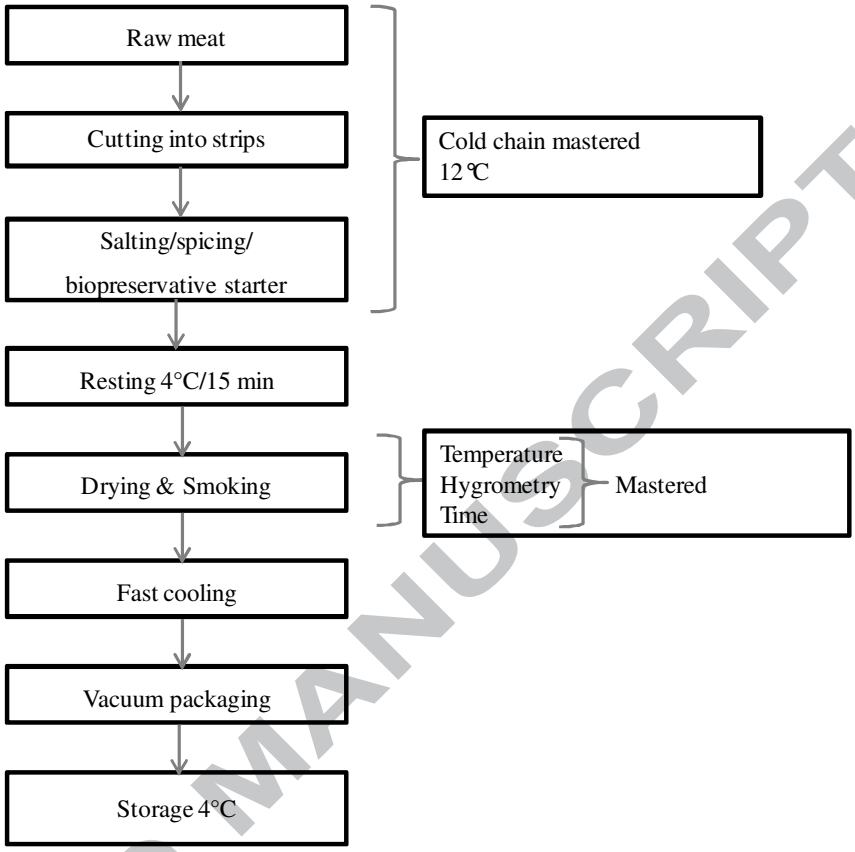

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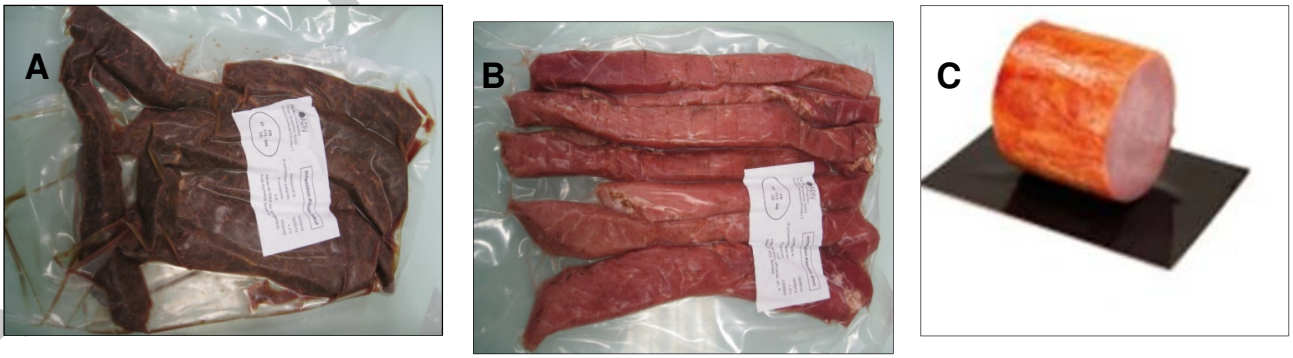
682 **Figure 2:**



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689 **Figure 3:**

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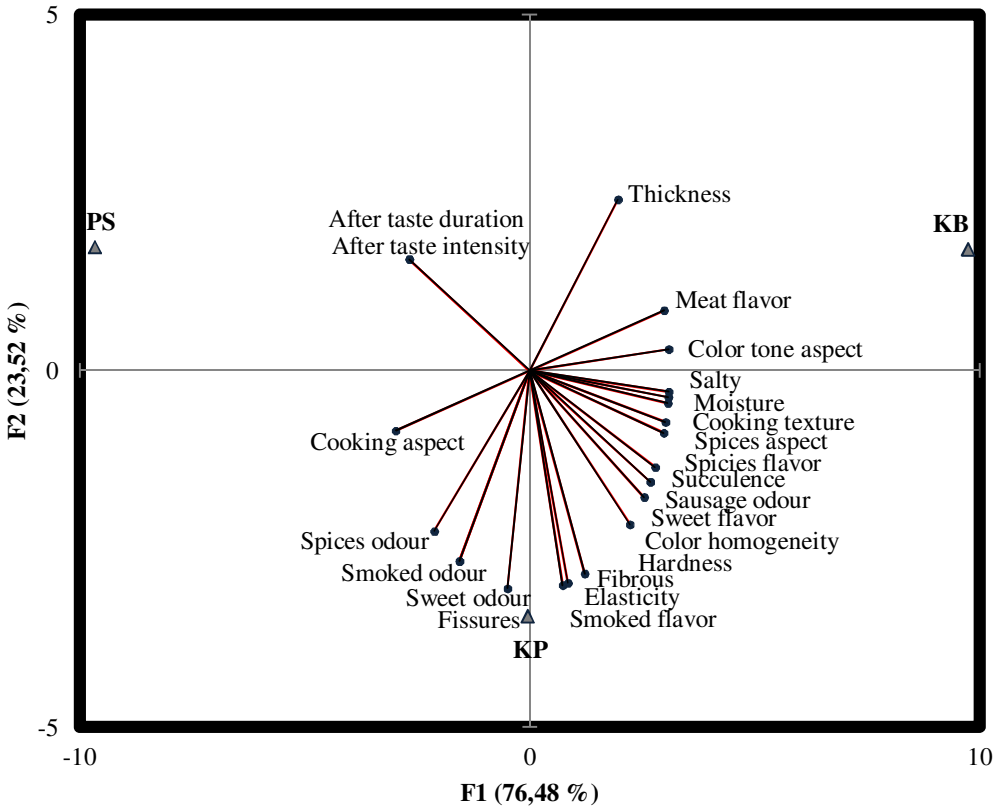

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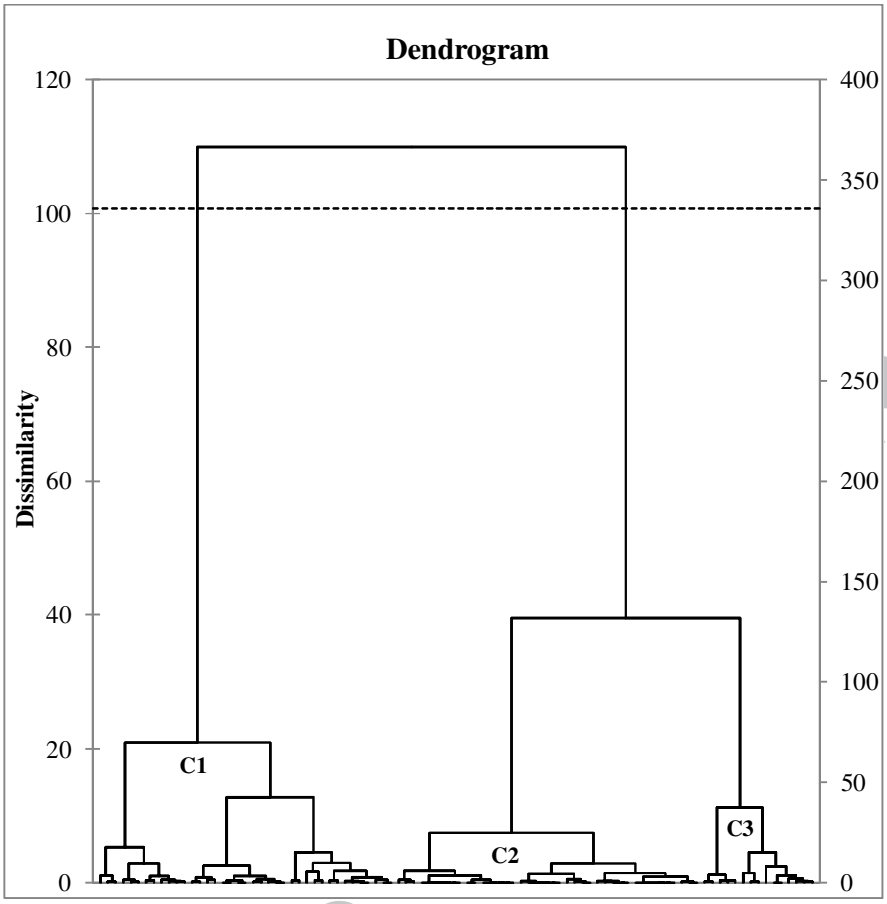

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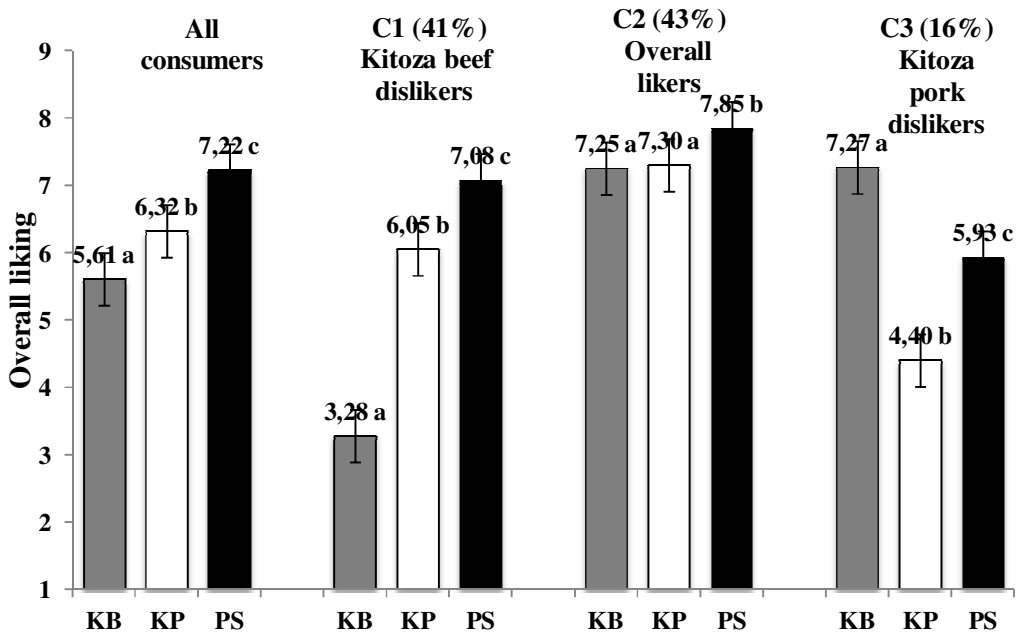


*Error bars represent the confidence interval of the mean (p = 0.95). Different superscripts within a cluster indicate significant differences according Tukey's HSD ($p \leq 0.05$).

Figure 6:

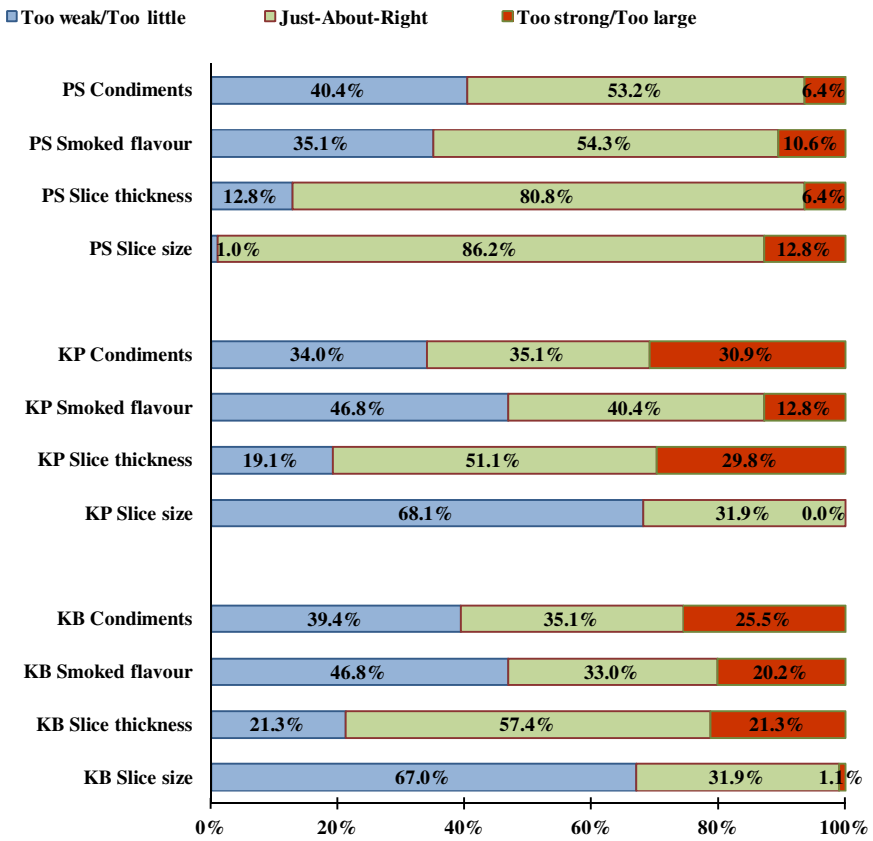
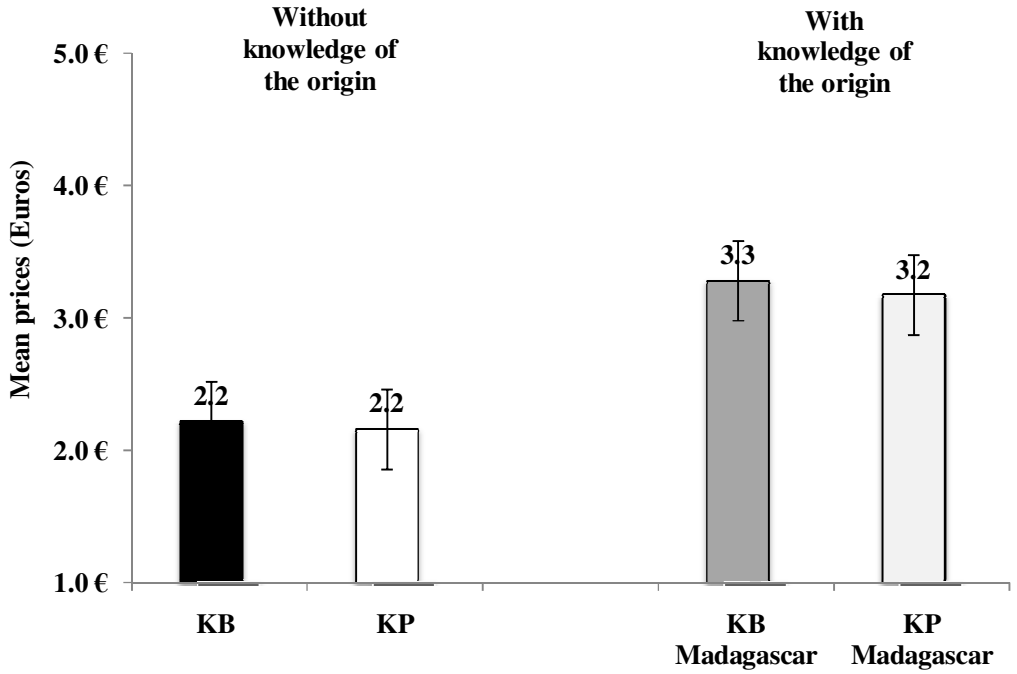


Figure 7:



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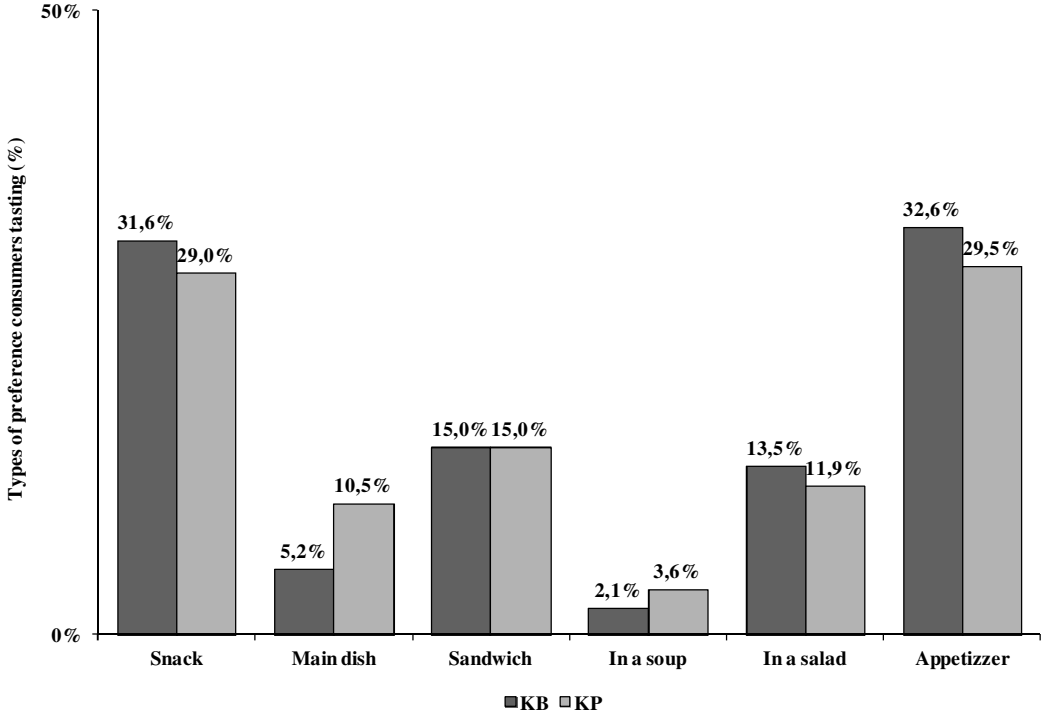

779 **Figure 9:**
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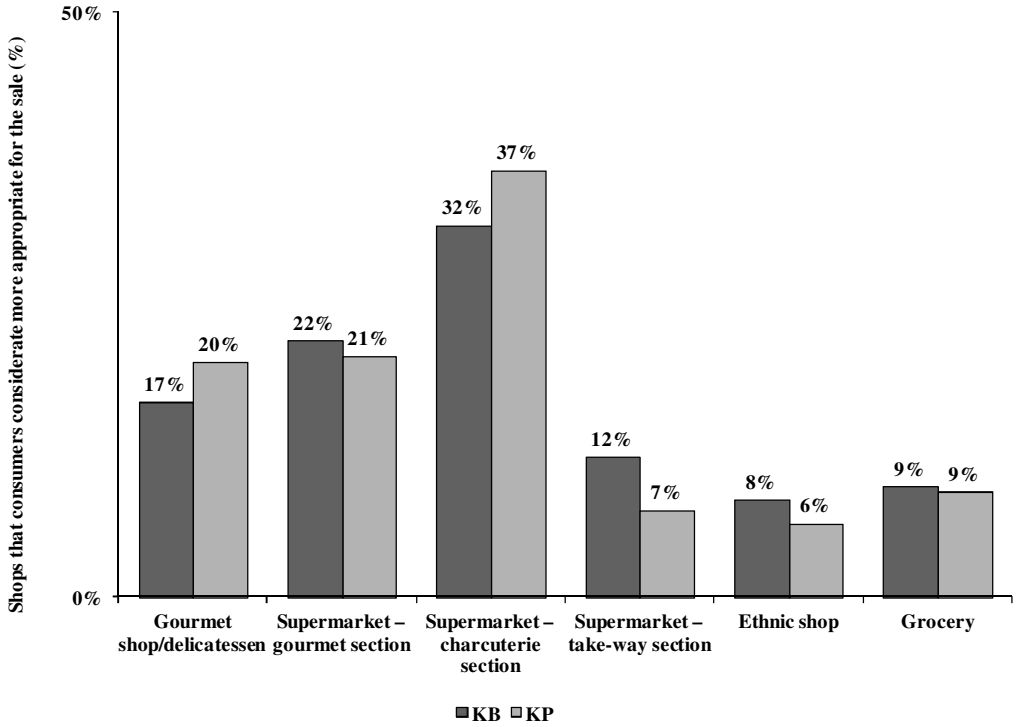

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Tables and captions:

Table 1 - Microorganisms analysed in the Kitoza manufactured with pork or beef.

	Method Reference	Pork* log CFU/g	Beef* log CFU/g
Total count 30 °C	ISO 4833	7.25 ± 0.05	7.04 ± 0.03
Coagulase negative staphylococci	**-**	6.63 ± 0.03	6.22 ± 0.08
Lactic acid bacteria	-	7.22 ± 0.08	7.18 ± 0.07
Yeast/mold	ISO 7954	2.26 ±0.01	2.43 ± 0.03
Enterobacteriaceae	ISO 21528-2	0.69 ± 0.08	1.74 ± 0.01
Staphylococcus aureus	ISO 6888-1	<2.0 log	<2.0 log
Listeria monocytogenes	ISO 11290-1	Absence (25g)	Absence (25g)
Salmonella	ISO 6579	Absence (25g)	Absence (25g)

* mean value of replicates ± standard deviation

812 **Table 2** - Form used in the 1st session of the Flash Profile to individually generate
813 sensory descriptors for Kitoza samples (Kitoza beef and Kitoza pork) and traditional
814 Portuguese smoked loin sausage.
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Sensory evaluation of meat samples

Panelist name _____ **Date** _____

	Attribute	**+Weak**	**+ Strong**
External aspect			
Internal aspect			
Odour evaluation			
Texture			
Taste/Flavour			
Others sensations			

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820 **Table 3** - Attributes form for meat samples used in the 2nd Flash Profile session in
821 order to guide the panellists to individually generate sensory descriptors for Kitoza
822 samples (Kitoza beef and Kitoza pork) and traditional Portuguese smoked loin sausage.
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Flash Profile

It is intended that the **SELECT** descriptors that in your opinion **BEST** differentiate at least two of the samples.
You can use the descriptors of this list or other you want.
The selection and number of descriptors to be used depends solely on **YOUR PERSONAL OPINION**.

	Attributes	Scale	
External aspect	Color tone aspect	Light	Dark
	Spices aspect	Without	Many
	Color pink - Brown	Pink / salmon	Brown
Internal aspect	Thickness	Absent	Thick
	Cooking aspect	Crude	Baked
	Visible fat	Absent	Much
	Color homogeneity	Heterogeneous	Homogeneous
	Internal fissures	Absent	Many
	Moisture	Dry	Moist
Odour evaluation	Spices odour	Absent	Strong
	Smoked odour	Absent	Strong
	Fat	Absent	Strong
	Sausage odour	Absent	Strong
	Dried meet	Absent	Strong
	Sweet odour	Absent	Strong
Texture	Hardness	Soft/tender	Hard
	Elasticity	Absent	Very elastic
	Succulence	Dry	Very juice
	Fibrous	Without fibers	Many fibers
	cooking texture	Crude	Well-done
	Soft	Rugged	Very soft
	Astringent	Absent	Strong
	Floury	Absent	Strong
	Granularity	Without granules	Many granules
Taste/Flavour	Spices flavor	Absent	Strong
	Salty	Weak	Strong
	Smoked flavor	Absent	Strong
	Sweet flavor	Absent	Strong
	Monoglutamate	Absent	Strong
	Sweet	Weak	Strong
	Meat flavour	Absent	Strong
After Taste	After tast intensity	Weak	Strong
	After tast duration	Short	Long

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Table 4 – Themes on the focus groups script.

Exploited topics of focus groups
A. Global sensory characterization
B. Attitude to buy
C. Consumption occasion
D. Consumption Motives
E. Willingness to pay
F. Local to buy
G. Others possible usages of Kitoza
H. Influence of African Origin on preference

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846 **Table 5** - Mean overall acceptability scores for the samples tested: Kitoza beef (KB),
847 Kitoza pork (KP) and Traditional Portuguese smoked loin sausage (PS).

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Samples	Average	Groups		
PS	**7.223±0.135**	**A**		
KP	**6.319±0.166**		**B**	
KB	**5.606±0.229**			**C**

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850 * Means value of replicates ± standard deviation with the same letter are not significantly
851 different Tukey test ($p<0.01$).
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869 **Table 6** – Correlations between sensory attributes (aspect, texture and flavour) and
870 acceptability of Kitoza samples and Traditional Portuguese smoked loin sausage. Kitoza
871 beef (KB), Kitoza pork (KP) and Traditional Portuguese smoked loin sausage (PS).

Variables		KB				KP				PS			
		Overall liking	**Aspect**	**Texture**	**Flavour**	**Overall liking**	**Aspect**	**Texture**	**Flavour**	**Overall liking**	**Aspect**	**Texture**	**Flavour**
KB	**Overall liking**	**1**	**0.732**	**0.745**	**0.915**	0.174	0.097	0.196	0.138	0.012	0.213	0.129	0.083
	Aspect	**0.732**	**1**	**0.716**	**0.732**	0.157	**0.538**	**0.586**	**0.875**	0.197	**0.676**	**0.759**	**0.845**
	Texture	**0.745**	**0.716**	**1**	**0.704**	0.193	**0.538**	**0.586**	**0.875**	0.197	**0.676**	**0.759**	**0.845**
	Flavour	**0.915**	**0.732**	**0.704**	**1**	0.192	0.097	0.196	0.138	0.012	0.213	0.129	0.083
KP	**Overall liking**	0.174	0.097	0.196	0.138	**1**	**0.538**	**0.819**	**0.875**	0.140	0.191	0.191	0.142
	Aspect	0.157	**0.538**	**0.819**	**0.875**	**1**	**1**	**1**	**1**	0.191	**1**	**1**	**1**
	Texture	0.196	**0.538**	**0.819**	**0.875**	**0.819**	**1**	**1**	**1**	0.191	**1**	**1**	**1**
	Flavour	0.138	**0.875**	**0.819**	**0.875**	**0.875**	**1**	**1**	**1**	0.142	**1**	**1**	**1**
PS	**Overall liking**	0.012	0.213	0.129	0.083	0.140	0.197	0.216	**0.213**	**1**	**0.676**	**0.759**	**0.845**
	Aspect	**0.213**	**1**	**0.759**	**0.845**	0.197	**1**	**0.759**	**0.845**	**0.676**	**1**	**0.759**	**0.845**
	Texture	0.129	**0.759**	**1**	**0.759**	**0.216**	**0.759**	**1**	**0.759**	**0.759**	**0.759**	**1**	**0.759**
	Flavour	0.083	**0.845**	**0.759**	**1**	**0.213**	**0.845**	**0.759**	**1**	**0.845**	**0.845**	**0.759**	**1**

Values in bold are different from 0 with a significance level alpha=0.05

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878 Highlights
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881 - Sensory profiles showed differences between the two Kitoza samples.

882 - Kitoza beef (KB) showed more intense meat flavour.

883 - Kitoza pork (KP) showed more intense sweet odour, spices and smoked odour.

884 - Between KB and KP samples, KP showed to be more appreciated.

885 - Geographic origin of Kitoza had a positive effect on consumers' willingness to

886 pay.

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