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Development of a Vegan Spanish Sausage-Type Using Coproducts from the Pepper "*Sol del Pilar*" †

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Abstract: The pepper "*Sol del Pilar*" (*Capsicum annuum L.*) from organic agriculture is a famous pepper certified with a quality brand in Spain (CV quality product). The peppers that not reach the high standard quality for their fresh commercialization are considered as coproducts and can be good raw material for the elaboration of vegan foods. The aim of this work was to develop a spreadable vegan blood sausage-type with these coproducts and to analyse their physicochemical, sensory, and microbiological properties. The final product showed a pH of 4.15 ± 0.1 and Aw 0.948 ± 0.006. The resulted product showed the following CIELAB colour co-ordinates: Lightness, 32.25 ± 1.62; Redness, 11.86 ± 0.97; and Yellowness, 13.90 ± 1.22. A consumer panel was used to evaluate its acceptability (hedonic scale). General aspect, spreadability, smell and texture were the attributes with higher scores (>6 in a scale 0–9). The use of coproducts from the pepper "*Sol del Pilar*" as ingredients for the development of vegan spreadable food products is a feasible alternative that could contribute to their valorisation and to increase the sustainability of this sector.

Keywords: vegan; food product development; *Sol del Pilar* pepper; coproducts; valorisation; organic foods

1. Introduction

Veganism is a way of life (philosophy of life) and in the Western societies has well stablished in few years; more and more consumers are approaching and adopting this new lifestyle [1], mainly young people (mostly teenagers). Vegans are, unlike other consumers, are demanders of high quality products. They prefer to buy and consume organic foods, "free of", sustainable foods (local foods, 0 km foods), among others [2]. They ask for good or excellent quality products, in foods, demand for the sensory properties of the vegan product. In this regard, they want that, the products they are going to purchase, have the same properties as the original, the non-vegan products. For food technologists, as well as for the multidisciplinary teams in the R&D departments, making vegan foods is a big challenge. Even more so when, they have to imitate a meat products.

The special technological (yields), techno-functional (WHC: water holding capacity; OHC: oil holding capacity, emulsifying properties, swelling properties, among others) and sensory

characteristics (colour, flavour, texture, mouthfeel, etc.) that provide meat raw materials, it is quite difficult to achieve in a meat analogue, with the same appreciated characteristics. Several meat analogues are already yet on the market such as Vegan-burgers, Bolognas-type, Frankfurter type vegan-sausages, among others emulsified analogues of cooked-cured meat products. Fortunately, for food product developers, there are quite a few auxiliaries (ingredients) to achieve these characteristics, mainly vegetable proteins (peas, wheat gluten or soy proteins, among others); however, the perfect imitation of the product is not always achieved.

The most recognized meat products of the Spanish Mediterranean gastronomy are the paprika added dry-cured meat products; their peculiar characteristics (spreadability, colour, aroma and flavour) are largely due to the meat proteins and spices. There are several formulas to produce these type of meat products, and make it difficult to do a meat analogue.

The special structure (food matrix) of the meat product makes its imitation very complicated, since reproducing the spreadability of the product with certain vegetable proteins is very difficult. Therefore, you have to look for other alternatives such as dietary fibres, gums and mucilage, from vegetables, to achieve the appropriate texture [3]. In terms of flavour and colour, many more spices are used than in a conventional product, thus being able to "mask" some unusual flavour of the product caused by the vegetable ingredients, not used in the original formula. This work requires the participation of multidisciplinary teams to apply strategies for the development of the product such as the UMH-5Star foods strategy [4] where a integrative vision about foods is applied (healthy, safety, tasty, sustainable and social accepted) such as the vegans demand from the industry.

One of the most important sources of raw materials for the elaboration of vegan products comes from the of the agri-food industries co-products valorisation. Many of these come from foods that do not meet any of the quality specifications, which are very strict, especially in quality brands such as the *Sol del Pilar* pepper (certified with a quality brand in Spain: CV quality product). Non-marketable peppers have the same technological and nutritional properties. That is reason that this "underutilized product" could be is an excellent raw material to be reused, in the development of new food products. Its composition and its technological properties make it ideal for its industrialization in certain analogues of meat products.

2. Objective

The aim of this work was to develop a spreadable vegan blood sausage-type with organic peppers "*Sol del Pilar*" co-products and to analyse their physicochemical and sensorial properties.

3. Materials and Methods

As a new product development, several aspects were considered, prior to its scale-up to a semi-industrial or industrial level. Physical (colour), physicochemical (pH, water activity, firmness and shear force) and sensorial properties were determined.

A prototype of spreadable vegan blood sausage were scale up at industrial level. All ingredients were cultivated in organic conditions. Vegetables and spices grown in Surinver greenhouse facilities. The percentaje of each ingredient in the vegan sausage formula and the industrial process is under protection by industrial property law. Eight independent elaboration process were made.

CIELAB (1976) colour parameters were evaluated: Lightness (L*), red/green (+/−) co-ordinate (a)*, yellow/blue (+/−) co-ordinate (b*) were measured using a spectrophotocolorimeter Minolta CM Minolta CM-700 (Minolta Camera Co., Osaka, Japan), using D_{65} as illuminant and 10º as standard observer. Psyco-physical magnitudes, Chroma (C*) and hue (H*) were calculated as: $C^* = (a^{*2} + b^{*2})^{1/2}$, $H^* = \tan^{-1}(b^*/a^*)$. Guidelines for colour evaluation was followed [6] and Sanchez-Zapata recommendations [7].

Texture properties (Firmness and shear force) was performed with a TextureAnalyser TA-XT2 (Stable Micro Systems, Surrey, UK). A compression test was made using a cup as sample container. Texture analyses were conducted on chilled (4 °C) samples. The samples were compressed to 70% original height with a compression load of 25 kg, and a cross-head speed for 20 cm/min. [8].

The pH was measured directly using a Hach puncture electrode probe (5233) connected to a pH-meter (model SensIONTM + pH3, Hach-Lange S.L.U., Vésenaz, Switzerland). The measurement was taken three times, changing the place of electrode insertion. The water activity (Aw) was measured at 25 °C using an electric hygrometer NOVASINA TH200 (Novasina; Axair Ltd., Pfaeffikon, Switzerland).

Sensorial analysis: Non-trained panellists (30) were recruited from the staff and students of the Miguel Hernández University, Alicante, Spain. Panellists were chosen on the basis of previous experience in consuming meat analoges. Furthermore, a preparatory session was held prior to testing, so that each panel could thoroughly discuss and clarify each attribute to be evaluated in vegan sausage-type meat analogue. Testing was initiated after the panellists agreed on the specifications. A Quantitative Descriptive Analysis was carried out [9]. All sensory work was carried out in the sensory laboratory at the University, which fulfils requirements according to the international standards [10,11]. During evaluation, the panellists were situated in private booths under incandescent/fluorescent light, with an intensity of approximately 350lx. The product was served over a cracker at room temperature. Each panellist evaluated three replicates of the sample. The sensory attributes were measured in a 0–9 scale. The attributes measured were: General aspect, acceptability, aroma, spreadability, fattiness, colour, saltiness, pepper taste and off-taste.

All samples analysis were measured by triplicate, except for colour measurements in which 9 measurements, from each sample, were made.

The experimental design was according with IPOA-5Stars methodology (healthy, safety, tasty, sustainable and social accepted foods [4].

A One-way ANOVA was used to evaluate the influence of elaboration process upon spreadable vegan blood sausage-type. When differences between levels were found, the Tukey's test was applied.

3. Results

Statistical analysis showed that not significant differences ($p > 0.05$) were found for all parameters under study (physical, psychochemical and sensorial) between all elaboration processes. With this, the results validate the scale up process to industrial level.

In Table 1 the results of physicochemical parameters (pH, Aw, CIELAB colour parameters and texture properties) of the spreadable vegan blood sausage-type are shown. Table 2 showed the results of the sensory analysis for spreadable vegan blood sausage-type. Figure 1 shows the vegan meat analogue developed with organic peppers "*Sol del Pilar*" co-products.

The pH and Aw values obtained in this new product development, suggest that its stability during its conservation will not have great problems. The pH value obtained is due to the acidic pH of the main ingredients used in the formulation, since it does not contain any type of additive.

The values of the L *, a * and b * colour co-ordinates are characteristic of the raw materials used, mainly from the organic *Sol del Pilar* pepper. However, the values obtained for the red/green (a*) and yellow/blue (b*+) co-ordinates were similar to those described in paprika-added meat products [12].

Table 1. Mean and standard deviation of pH, water activity (Aw), and CIELAB colour parameters (L*: lightness; a*: red/green co-ordinate (+/−); b*: yellow/blue co-ordinate (+/−); C*: Chroma and H*: hue), firmness and shear force of a spreadable vegan blood sausage-type elaborated with organic red *Sol del Pilar* peppers.

Parameters	Spreadable Vegan Blood Sausage-Type
pH	4.15 ± 0.01
Aw	0.948 ± 0.006
L*	32.25 ± 1.62
a*	11.86 ± 0.97
b*	13.90 ± 1.22
C*	25.71 ± 0.99
H*	49.62 ± 1.19

Firmnes (Kg)	1.50 ± 0.68
Shear force (Kg.s)	1.62 ± 0.11

Table 2. Mean and standard deviation of sensorial analysis parameters (general aspect, acceptability, Aroma, spreadability, fattiness, colour, saltiness, pepper taste and off- taste) of spreadable vegan blood sausage-type elaborated with organic red *Sol del Pilar* peppers.

Parameters	Spreadable Vegan Blood Sausage-Type
General aspect	6.87 ± 1.65
Acceptability	6.65 ± 1.07
Aroma	6.17 ± 1.53
Spreadability	6.70 ± 1.26
Fattiness	6.13 ± 1.34
Colour	3.09 ± 0.60
Saltiness	2.96 ± 0.68
Pepper taste	3.04 ± 0.24
Off-taste	2.71 ± 1.24

The attributes most valued by the panelists were general aspect, acceptability, aroma, spreadability and fattiness. Panelists gave the highest ratings to overall appearance, spreadability and acceptability. This suggests that the developed product meets the sensory expectations of the panelists in the most characteristic attributes of this type of product. Keep in mind that it is a product that is going to be marketed as a spreadable product. It should be noted that the panelists did not detect strange flavors in the product. Panelists detected a low pepper flavor.

Figure 1. Spreadable vegan blood sausage-type formulated with organic *Sol del Pilar* peppers.

4. Conclusions

This work is a practical application in an industrial scale for the use of "ready to measure" parameters to evaluate important practical parameters that can decide the reformulation or acceptation of the product to scale up to make a local consumer test. The good acceptability obtained of this product indicated that the use of *Sol del Pilar* co-products is a very good source of raw material for vegan food formulations.

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