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Processing and evaluation of sensory and proximal quality in canned pork stew *Sus scrofa domestica* in adobo sauce

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ABSTRACT

The objective of this study was to elaborate and determine the sensory and proximal quality of canned *Sus scrofa domestica* pork cuts in stew sauce, in order to obtain a palatable and nutritious product. The product was made based on *Sus scrofa domestica* pork, *Solanum tuberosum* potato, *Phaseolus vulgaris* canary bean, as main inputs and other inputs for culinary use in Peru. Each container contained 460 g has 120 g rice, 100 g of potatoes, 80 g of meat, 20 g of carrots, 20 g of peas, 2 units of pepper, 1 clove of garlic and 2 g of salt. The minimum lethality value (F0) of 6.11 minutes, thus achieving commercial sterility for 48 min at 117 °C. The microbiological analysis indicated the absence of mesophilic and thermophilic microorganisms, therefore, this preserve was called commercially sterile and suitable for human consumption. The study evaluated 3 government liquid formulations, which were subjected to a sensory evaluation carried out with 20 semi-trained panelists whose result was sample 041 (F3) for better aroma and flavor, sample 031 (F2) for texture and juiciness. sample 021 (F1). The proximal chemical composition processed for the pork pieces was 17.78±0.02 protein, 19.32±0.35 fat, 61.11±0.29 moisture, and 0.93±0.04 ash. For the bean it was 6.18±0.53 of proteins, 0.85±0.04 of fat, 75.47±0.046 of humidity and 1.26±0.05 of ashes and the processed potato 4.07±0.06 of proteins, 0.26±0.01 of fat, 73.82±0.08 of humidity and 2.91 ±0.04 ash

Keywords: Pork Meat; potato, bean; stew sauce; canned; heat treatment and physical sensory evaluation, chemical evaluation

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1. Introduction

Peru, according to INEI (2023), has 27.5% of the urban poor population and 41.1% of rural poverty, and its diet is based on cereals, tubers, fruit and food animals, the first two being excessive and the last two being deficient (Brewer et al., 2021).

The **domestic pig** (*Sus scrofa domestica*) is one of the most consumed animals in the world, after chicken, with a per capita consumption of 16 kg/year (Yu & Jensen, 2022). The nutritional value of pig muscle varies depending on the breed and feed provided; its easily digestible protein can vary from 18-24%, mostly saturated lipids from 3-10%, vitamins from 1% and minerals from 1% (Lebret & Čandek-Potokar, 2022).

The possibilities of valorizing the products generated in the slaughter and butchering of such a large number of animals far exceeds the commercial output of the aforementioned products. The first way of use is the direct use as food in traditional cuisine as well as among culinary novelties.

Another input of Peruvian origin is the potato (*Solanum tuberosum*), with more than 7,000 years of cultivation, it is the basis of our gastronomy; of great genetic diversity with native and improved varieties on different ecological roofs, it is the economic sustenance of numerous families, (Maiti & Singh, 2022). The low level of lipids and high in minerals, vitamins and caloric nutritional value has diversified its consumption; In addition, it has phytochemical components that prevent degenerative diseases (Arshad, et al., 2021); above all, colored potatoes, which provide essential antioxidants such as ascorbic acid, carotenoids, β -carotene, minerals, and polyphenols (Alam, 2021). We also have the **bean** (*Phaseolus vulgaris L.*); a low-lipid legume that provides nutritional benefits and is considered a nutraceutical, used in the treatment of diabetes and obesity (Bai et al., 2023); source of protein, B vitamins, calories, dietary fiber with a hypoglycemic effect and antioxidant capacity (Rodríguez et al., 2021)

A preparation of Peruvian cuisine that is widely consumed is very traditional or ethnic in our environment (Karizaki, 2016), is the stew called "estofado", based on meat, beans, potatoes, rice and a sauce based on vegetables and spices, and which has a good nutritional contribution.

Heat treatment is the main and traditional method of microbial inactivation, where *Clostridium botulinum* are the benchmark for establishing heat treatment efficiency scales for canned preserves. However, these benefits of heat treatment come with some undesirable effects on food, such as changes in physicochemical properties and organoleptic characteristics (Munir et al., 2023).

The global demand for home-cooked packaged meals has increased due to the shift in consumer behavior towards prepared foods. Among the variety that stand out, are the canned instant dishes, which are packaged according to the "palate" of the country or region; even, of any edible animal species, exotic recipes, vegetarian, soups, fruit dessert (Bumbudsanpharoke & Ko, 202)

The objective of this research was to elaborate and determine the sensory and proximal quality of pork stew preserves *Sus scrofa domestica* in a marinade sauce based on potatoes and beans, in order to obtain a palatable and nutritious product.

2. Material and methods

Place of execution

The experimental part of the process in the Pilot Canning Plant of the Fisheries School of the Jorge Basadre Grohmann National University (UNJBG). The determination of heat treatment time, proximal analysis and commercial sterility were carried out at the Technological Institute of Production.

Raw material

Pork cuts were purchased according to the Sanitary Standard for beef and pork (MINAGRI, 2012), non-sandy white potato, Canarian beans, rice (*Oryza sativa*), soybean oil (*Glycine max*), fresh peas (*Pisum sativa*), carrot (*Daucus carota*), red onion (*Allium cepa*), cassava flour (*Manihot esculenta*), pepper (*Piper nigrum*), ground cumin (*Cuminum cyminum*), oregano (*Origanum vulgare*), tomato (*Solanum lycopersicum*), garlic (*Allium sativum*) and bay leaf (*Laurus nobilis*). All the supplies were purchased in the town of Tacna.

Preserved

The formulation for the canned pork stew *Sus scrofa domestica* in adobo sauce is shown in

table 1, it was made based on a traditional hunting recipe.

100,0 Formulation of canned pork cuts *Sus scrofa domestica* in stew sauce

Ingredients	%
Rice (g)	26,1
Sliced potato (g)	21,7
Meat in pieces (g)	17,4
Sliced carrot (g)	4,3
Bean (g)	4,3
Black pepper (unit)	1,1
Garlic clove (unit)	1,1
Common salt (g)	0,4
Government fluid (g)	17,4
Brine 2.5%	6,1
	100,0

Materials and equipment used

Equipment: Vertical laboratory autoclave, Bionet brand 2500 W, with ranges from 0-160 °C, SORES brand benchtop scale (capacity: 1.5 kg, accuracy: 0.01 g), SORES brand benchtop scale (capacity 16 kg, precision 1 g), SURGE brand 3-burner industrial gas cooker, LANICO brand semi-automatic sealer with four rolls of stainless steel, Maquipprocesos (Temperature 98 – 100°C, power 1.5 HP, speed 1-6 m/min, capacity 0.2m/sec), Oster blender (power 3 HP), Thermo recorder, brand ELLAB, model TRACK SENSE PROLOGERS.

Materials: high-density polyethylene bags. Size 46x76 cm, round stainless steel containers, stainless steel trays. 53x32.5x2.5 cm / 32.5x26.5x2.5 cm, stainless steel strainer ø 26 cm, 1/4 club tin containers (104 x 60 x 27 mm), 7 L stainless steel pot, graduated pipette 10 ml, stainless steel frying pan ø 30 cm, stainless steel utensils (spoon, slotted spatula, tasting spoon), beaker 400 ml.

Experimental scheme

Three formulas of governing fluid (see table 2) were evaluated, which were used in the formulation of canned slices of pork *Sus scrofa domestica* in stew sauce in table 1.

Analytical Methods of Evaluation

• Process

Primary process: The pork was chopped, washed and boiled for 2 min, cooled and then macerated with salt, pepper, ground cumin and stored for 24 h at 5°C, in a glass container (Kim et al., 20182). The White Potato

30 Experimental Design for the 3 Governing Fluid Formulas

Ingredients	F1	F2	F3
Soybean oil (L)	1	-	-
Olive oil (L)	-	1	1
Red grape wine (ml)	-	-	250
Ground garlic (g)	50	50	50
Ingredients	%	Rice (g)	26,1
Sliced potato (g)	21,7	Meat chunks (g)	17,4
Sliced carrot (g)	4,3	Beans (g)	4,3
Black pepper (unit)	1,1	Garlic clove (unit)	1,1
Common salt (g)	0,4	Governance Fluid (g)	17,4

(INDECOPI, 2010), was washed, peeled and sliced (Binner, Jardine, Renard, & Jarvis, 2000), then boiled for only 5 min. The Canarian bean has been washed and rehydrated for 18 h (Haladjian et al., 2007), and then boiled for 5 min. The rice was washed and pre-cooked (Yu et al., 2017), only half-grained. The peas were shelled and the carrot peeled, then pasteurized for 2 min (Aamir et al., 2013).

Elaboration process: The flow of operations is carried out as shown in Figure 1. The preparation of the governing fluid liquid was done in a stainless steel container, where three types of sauce (F1, F2 and F3) were prepared in order to be added to the containers, preparing each one for 30 min over low heat (MIDIS, 2019) with the following ingredients from table 2. Evacuation and sealing was done in the exhauster for 90 sec at a temperature between 95 and 100°C (MINSAs, 2007). The packaging was done in 1 lb tall containers (INACAL, 2015). Sterilization was performed according to Pflug, Odlaug, & Christensen (1985) and Patazca, et al., (2013). The treatment was performed at 117°C x 48 min. The determination of the Fourier value or lethality

(Fo) was carried out with the Fourier value or lethality (Fo) and the temperature at the coldest point of the cylindrical container was recorded, sterilization was done between 115-117°C (Dincer, 1998); temperatures below 150 °C were also recorded. The calculations that determine the time of the process were by the General Method, which is applied to any thermal process or product (Miranda-Zamora et al., 2022; Simpson et al., 2003), and created in 1920 by Bigelow (Friso, 2015).

Determination of Heat Treatment Time

A study was carried out to determine the heat treatment time according to the sanitary standard applicable to the manufacture of low-acid and acidified packaged foods intended for human consumption according to INACAL (2010).

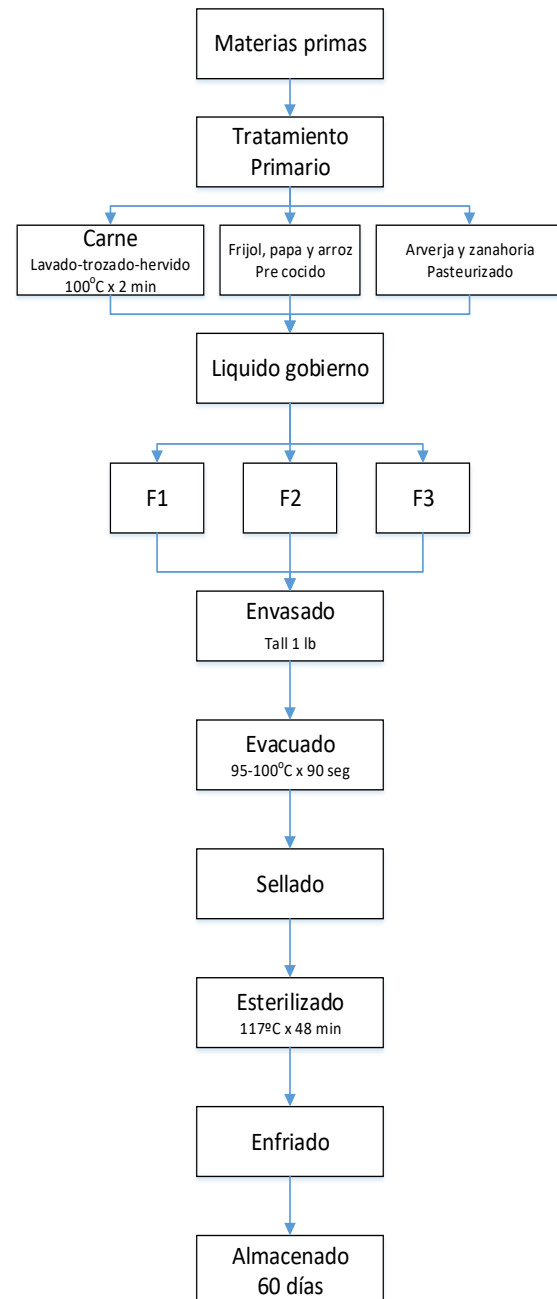


Figure 1. Flow of operations for the production of canned pork cuts *Sus scrofa domestica* in stew sauce. In original Spanish language

• Final Product

Proximal chemical analysis: After the 60-day quarantine subjected to canning, the analysis of proteins, moisture, lipids, ash and carbohydrates was carried out according to the methods (FAO, 1986); ITP, 2009).

Determination of pH: To determine pH, the sample was homogenized in distilled water at a ratio of 1:9, measured in triplicate and according to the methodology recommended by (AOAC, 1996).

Commercial sterility: After the storage time and as no bulging container was observed, the analysis of bacteria was carried out, according to the standard of canned fishery products in airtight containers. Sterility control tests were for the determination of aerobic (thermophilic and mesophilic) and anaerobic (thermophilic and mesophilic) microorganisms. (INACAL, 2010; ICMSF, 2000).

Physical sensory evaluation: In order to obtain a qualification of the organoleptic characteristics of the preserves, a descriptive evaluation sheet was prepared, but quantitatively differentiated from the most important sensory attributes of the new food, with a 9-point hedonic scale: taste, smell, texture and juiciness (Maaya & Al-Abdullah, 2016). From each canning container, once heated in a bain-marie, four portions were obtained for the same number of panelists, who were served the three samples F1, F2 and F3 randomly, identifying themselves as samples 021, 031, 041 respectively. There were a total of 20 semi-trained tasters (Hamasalim, 2012).

Statistical analysis

The results of the sensory evaluation of the canned food were statistically evaluated with the completely randomized design (DCA), through analysis of variance (ANOVA), with each sample being a treatment, with the Statistical Analysis System (SAS), version 9; Tukey's multiple mean test was used to determine the best treatment, with a significance level of $\alpha=0.05$.

3. Results and discussion

This work *Sus scrofa domestica in marinade sauce*, in adobo sauce, compared to similar products

Brine 2.5%	6,1	Fuente
100,0	54 min x 116,00°C	Mancilla & Gallegos (2021)
Arequipa marinade	34 min x 121,00°C	Lima, Valverde, & Zanabria (2019)
Choros in adobo sauce	Fo=9,754 min 75 min x 114,00°C	Valdivia & Ruyeri (2018)
Pork stew <i>Sus scrofa domestica</i> in adobo sauce,	Fo=6,173 min 66 min x 115,41°C	Presente trabajo

Process

Determination of heat treatment time: The experimental results of the heat treatment test are shown in Figure 2, whose curves represent the heat penetration curves of the canning (Leonhardt, 1978; ITP, 1993; Simpson et al., 2003; Pflug, 1985). The curves were constructed from the Ellab-Valsuite system, where the left scale of the graph shows the temperatures (°C) of the process versus the exposure time (min) necessary for the death of *Clostridium botulinum* and the scale on the right the F0 value (min.).

At 19 minutes, it was concluded that the thermal process time for canned pork cuts *Sus scrofa domestica* in stew sauce was 66 minutes at 115.41°C with F0 = 6.173 minutes (Table 3), enough time to eliminate *Cl. botulinum*, its spores and achieve commercial sterility. as stated (Munir et al., 2023), the values should be between 6 and 14 min. Similar preserves were made by Kusumaningrum et al. (2022), who achieved Fo = 4.02, canning beef, the values lower than ours, it may be because the muscle tissue of the beef is weaker, in addition, tomato sauce has a pH lower than 4.6 (Vásquez et al., 2007). We can also see in Table 3 the different temperature and time parameters in heat treatment with an inverse relationship for similar preserves. In the case of Arequipa marinade, according to Lima, Valverde, & Zanabria, (2019), the treatment temperature is lower (121°C) but uses a shorter time (34 min). In the same way, we have choros in adobo sauce (Valdivia & Ruyeri, 2018), where the treatment temperature is 114°C, but it takes a longer time (75 min).

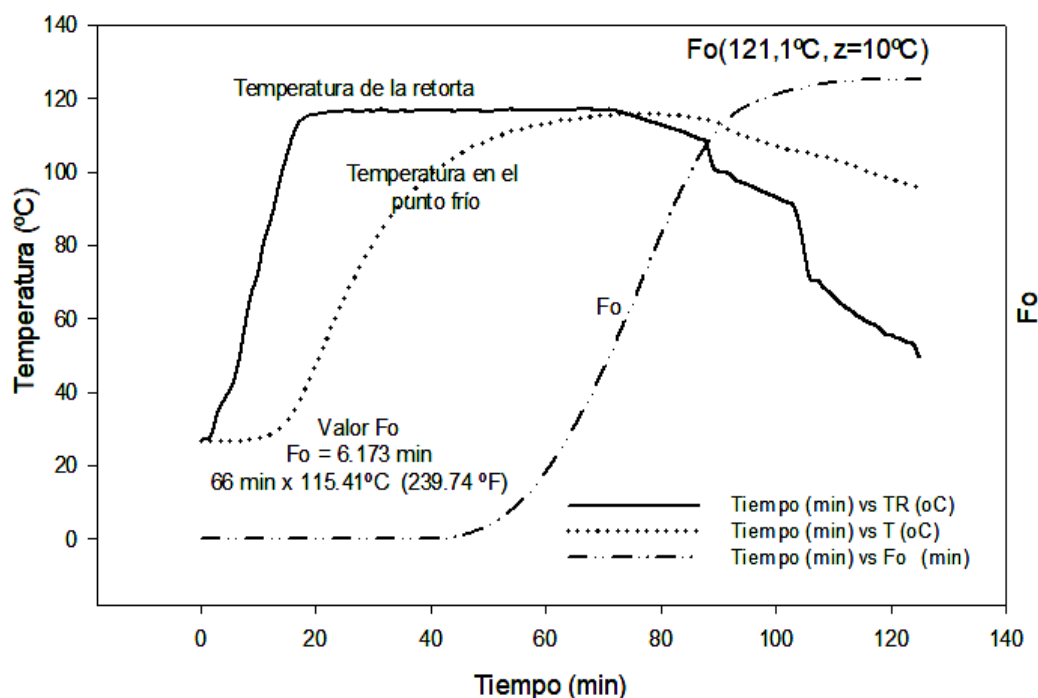


Figure 2. Heat Penetration Curve in Canned Canned Pork Cuts *Their scrofa domestica* in stew sauce. In original Spanish language

Final product

Proximal chemical analysis: Table 3 shows the analysis of proximal composition, obtaining a low moisture value and a high fat value, possibly due to the design of the recipe and the high amount of vegetable oil in the design of the governing fluid.

Table 4 below shows the different proximal compositions of the

products similar to the canned pork stew *Sus scrofa domestica* in adobo sauce, where different proximal values result, which may be due to the free use of different recipes. The ash content ($1.70 \pm 0.04\%$), a result very similar to those reported in Table 4.

This work ± 0.04 in marinade sauce,

Component	%	
	F1	F3
Soybean oil (L)	$1 \pm 0,02$	$1 \pm 0,02$
-	$\pm 0,35$	$\pm 0,35$
Olive oil (L)	$\pm 0,04$	$\pm 0,04$
1	$1 \pm 0,02$	$1 \pm 0,02$
Grape red wine (ml)	-	-

Determination of pH: The pH of canned food was 5.61 ± 0.03 against 4.86 of canned marinade according to Lima, Valverde, & Zanabria (2019), probably due to the use of chicha de jora and according to NTS 069 MINSA/DIGESA-V.01. (MINSA, 2008) canned food is a low-acid food. This is important because low-acid foods can still have the growth of thermosturent and spore-forming pathogens; The latter are removed during heat treatment, which ensures their safety.

5.61 ± 0.03

-	250 %	Ground garlic (g) %	50 %	50 %	50 %	Tomato paste (g)
100	100	100	Chopped red onion (g)	100	100	100
Ground Brown Bell Pepper (g)	20	20	20	Ground oregano (g)	10	10
10	Common salt (g)	30	30	30	12,50	Valdivia & Ruyeri (2018)
Pork stew Sus scrofa domestica in adobo sauce,	41,29 ± 0,29	6,36 ± 0,02	17,23 ± 0,35	1,70 ± 0,04	26,43 ± 0,02	Present work

N°	Scent			Flavor			Texture inputs			Jugosidad		
	021	031	041	021	031	041	021	031	Type of spreads	Heat treatment	Fountain	Spicy Tacneña
54 min x 116,00°C	Mancilla & Gallegos (2021)	Arequipeño Adobo	34 min x 121,00°C	Lima, Valverde, & Zanabria (2019)	Choros in adobo sauce	Fo=9.754 min 75 min x 114.00°C	Valdivia & Ruyeri (2018)	Pork stew	Fo=6.173 min 66 min x 115.41°C	This work	7	7
2	7	8	9	6	7	7	7	9	8	7	6	6
Component	%	6	Pork Stew	Humidity	41.29 ± 0.29	Protein	6.36	Grease	17.23	Ash	1.70	Carbohydrate
26.43	pH	5.61 ± 0.03	8	7	7	8	6	Type of spreads	Humidity	Protein	Fat	Ash%
Carbohydrates	Fountain	Spicy Tacneña	78,80	5,43	3,54	1,61	10,34	Mancilla & Gallegos (2021)	Arequipeño Adobo	70,23	3,06	3,67
2,31	20,44	Lima, Valverde, & Zanabria (2019)	Choros in adobo sauce	60,70	19,3	5,70	1,80	12,50	Valdivia & Ruyeri (2018)	Pork stew	41.29 ± 0.29	6.36 ± 0.02
17.23	1.70	26.43 ± 0.02	This work	7	8	8	6	8	6	Analysis	6	Result
Mesophilic aerobes	7	Absence	9	8	8	7	6	7	6	7	5	N°
Aroma	Taste	Texture Inputs	Juiciness	9	021	031	041	021	031	041	021	031
041	021	031	041	1	7	7	8	8	9	8	7	8
7	8	7	7	2	7	8	9	6	7	7	7	9
8	7	6	6	3	6	6	8	6	6	8	6	8
7	9	7	6	4	7	6	8	7	7	8	6	7
6	8	7	7	5	7	8	7	7	8	9	6	7
5	7	5	7	6	6	8	8	8	7	7	7	6
7	8	7	6	7	8	7	6	7	8	8	6	8
6	7	6	8	8	7	7	9	8	8	7	6	7
6	7	5	7	9	8	8	7	9	7	8	7	8
6	8	6	5	10	6	7	7	8	8	7	6	7
8	7	7	6	11	7	7	8	6	7	8	6	7
5	7			8			6			12		
8	6			7			7			6		

Commercial sterility: Table 4 shows the results reported after 60 days of storage, showing no growth of aerobic mesophilic and anaerobic (thermophilic) microorganisms, qualifying it as a commercially sterile product; that is, the

product is safe and suitable for human consumption.

Absence

Analysis	Result
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Aerobic mesophilic	Absence
mesophilic	Absence
anaerobes	Absence
Aerobic	Absence
thermophiles	Absence
Anaerobic	
thermophiles	
Fungi and yeast	

Sensory Evaluation:

The optimal formulation was determined using a questionnaire to evaluate sensory attributes (taste, smell, texture and juiciness), with a 9-point hedonic scale (see table 5). Samples were identified as 021 (F1), 031 (F2) and 041 (F3). According to the results of 20 panelists who evaluated the preserve, using the analysis of variance (ANOVA) with a significance level of 0.05, we report that in the **aroma**, there were

021 (F1) in adobo sauce.

4. Conclusions

The process flow for the production of canned pork stew *Sus scrofa domestica* in marinade sauce was as follows: reception of material, primary treatment corresponding to the washing, cutting, pre-cooking and pasteurization of vegetables, preparation of the governing liquid, addition of inputs, packaging, evacuation, sealing, washing of cans, sterilization, cleaning, packaging and storage. The F0 value found for the canned pork stew *Sus scrofa domestica* in adobo sauce. potato and bean-based was 6.57 min for a thermal process time of 18 min (CUT) and sterilized for 46 minutes at 117 °C.

The results of commercial sterility carried out on the canned pork stew *Sus scrofa domestica* in marinade sauce reported the absence of thermophilic and mesophilic microorganisms, being the product suitable for human consumption.

Their *scrofa domestica* in adobo sauce have a proximal chemical composition of 17.78±0.02 protein, 19.32±0.35 fat, 61.11±0.29 moisture and 0.93±0.04 ash.

The experimental test with the highest degree of satisfaction in aroma was sample 041 (F3); with respect to taste, the differences were not significant (P> 0.05); however, there were numerical differences, with treatment 041 (F3) being the best; highly significant differences

were observed in texture and juiciness (P< 0.05), and according to the Tukey test, sample 041 has a higher score (154); , the differences were not significant (P> 0.05); however, there were numerical differences, with treatment 041 being the best; highly significant differences were observed in **texture and juiciness** (P< 0.01), the best for texture was 0.31 and in juiciness treatment 021. It is known that meat and the precursors of the flavor of slaughter animals such as pork, is influenced by the composition of their food (Navarro et al. 2021). Regarding the potato, Binner *et al.* (2000), determined that the action of heat activates its pectins when they are demethylated, thus achieving their softening. High-pressure cooking of rice has the potential to improve sensory quality (Yu *et al.*, 2017).

were observed in texture and juiciness (P< 0.01), the best for texture was 0.31 (F2) and in juiciness treatment 021 (F1).

A commercial product was obtained from canned pork stew *Sus scrofa domestica* in adobo sauce, providing an alternative to take advantage of a dish directly from traditional cuisine, nutritious and rich in proteins, a long shelf life of up to 4 years.

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