DOI: https://doi.org/10.36955/RIULCB.2024v11n1.011

Original Article

Preparation of cookies with passion fruit peel flour (*Passiflora edulis*) enriched with anchovy protein concentrate (*Engraulis ringens*)

Elaboración de galletas con harina de cáscara de maracuyá (Passiflora edulis) enriquecido con concentrado proteico de anchoveta (Engraulis ringens)

Yosef Avalos-Ramírez Miguel Grados-Poémape Stainer Curibanco-Chinchihuara

Cesar Moreno-Rojo Lizeth Santiago-Castillo

yavalos@uns.edu.pe

Universidad Nacional del Santa. Ancash, Peru.

Received: 23/08/2023 Review: 09/11/2023 Accepted: 02/12/2023 Published: 02/01/2024

ABSTRACT

Fruit waste has multiple uses in the food industry, such as in the production of flour from pineapple, pitahaya or passion fruit peels. In turn, it will be proven that these foods offer a valuable nutritional contribution to the body. In recent times, there has been notable progress in the food industry, with a growing focus on creating innovative and sustainable products. In this context, the research focused on the preparation of cookies where unconventional ingredients are used, such as passion fruit, which are characterized by their richness in bioactive and antioxidant compounds. Likewise, their optimal formulation was found using 95 % flour. wheat, 3 % shell flour and 2 % hydrolyzed anchovy protein concentrate. A particularly interesting aspect of the study was the incorporation of hydrolyzed anchovy protein concentrate, a rich source of protein and omega-3. In addition, a physical sensory analysis was carried out resulting in satisfactory acceptance, it will be obtained that these cookies offer a significant contribution of nutrients beneficial to health.

Keywords: Food industry, antioxidants, proteins and health.

RESUMEN

Los residuos de frutas tienen múltiples usos en la industria alimentaria tal como lo es en la elaboración de harina de cascara de maracuyá. A su vez, se observó que este alimento ofrece un aporte nutricional valioso para el organismo. En los últimos tiempos, se ha producido un avance notorio en la industria alimentaria, con un enfoque creciente en la creación de productos innovadores y sostenibles. En ese contexto, la investigación se centró en la preparación de galletas donde se utilizan ingredientes no convencionales,

como el maracuyá, que se caracterizan por su riqueza en compuestos bioactivos y antioxidantes, así mismo se encontró su formulación óptima usando el 95 % de harina de trigo, 3 % de harina de cascara y un 2 % de concentrado proteico hidrolizado de anchoveta. Un aspecto particularmente interesante del estudio fue la incorporación de concentrado proteico hidrolizado de anchoveta, una fuente rica en proteínas y omega-3. Además, se realizó un análisis físico sensorial resultando en una aceptación satisfactoria, se observó que estas galletas ofrecen un aporte significativo de nutrientes beneficiosos para la salud.

Palabras clave: Industria alimentaria, antioxidantes, proteínas y salud.

INTRODUCTION

Currently, in the food industry, the combination of innovation and sustainability is essential for the creation of culinary products (Sadiku *et al.*, 2019). Fruit and vegetable waste, such as peels, often contain higher levels of bioactive compounds compared to the part that is consumed (Enemegio, 2023). Mismanagement and poor handling of organic waste generate an environmental problem in cities (Pardavé & Mendoza, 2023). Industries that process fruits generate waste such as leaves, seeds, peels and other waste (Morales *et al.*, 2019). If not managed properly, this waste can represent a threat to the environment (Aguilar, 2022), and entail significant disposal costs (Lin *et al.*, 2020).

However, the manufacture of by-products will reduce the negative ecological impact (López *et al.*, 2021), and the proper use of these by-products as ingredients significantly benefits the food industry (Prakash, 2020). Before, agroindustrial waste was discarded, but research shows that since the 70s this perception has changed; companies are currently showing interest in taking advantage of this waste due to its high nutritional value (Chung *et al.*, 2018).

Passion fruit peel flour with a protein content of 5.14 % and a high crude fiber content of 28.33 % (Chuqui and Paucar, 2021) stands out for also presenting antioxidants, such as 18.358 ± 0.384 mgEAG/g of phenols total and 0.091 ± 0.012 mgEC3G/g of total anthocyanins, offering hypoglycemic properties (Osso & Lazo, 2019). On the same topic, Sánchez *et al.* (2019) published that the inclusion of flour derived from passion fruit peel in the feeding of ruminants is presented as a feasible option, allowing the replacement of up to 10 % of the corn content in their diets, in addition, the different amounts of peel flour Passion fruit not only improves productive results, but also generates greater economic profits (Castro, 2023).

Hydrolyzed anchovy protein concentrate; In 100 grams of it it contains: 80 g proteins, 512.6 mg phosphorus, 5.961 mg iron and 80 g proteins. Roland *et al.* (2021) produced an anchovy protein hydrolyzate powder with sensory, physical-chemical and microbiological characteristics suitable for use in food. In this powder, the presence of lysine, an essential amino acid relevant to nutrition and related to childish development, was highlighted.

This confirms the nutritional value of the anchovy hydrolyzate, demonstrating a commitment to both quality, consumer health and environmental sustainability, in this case because the passion fruit peel will be reused (Montero, 2020). This study focuses on creating healthy products, such as cookies, from passion fruit peel flour, with hydrolyzed anchovy protein concentrate, and evaluating their satisfaction through surveys.

MATERIALS AND METHODS

The processing of 20 kg of passion fruit was carried out, implementing various stages to guarantee the quality of the final product. First, the washing, disinfection and selection of the fruits was carried out.

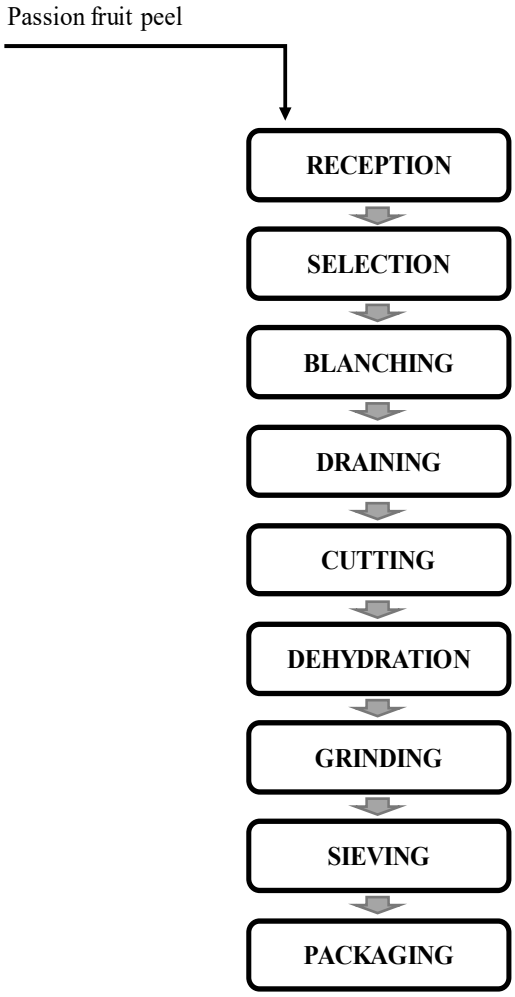

Figure 1. Flow diagram for the preparation of passion fruit peel flour

Subsequently, blanching, draining and cutting were carried out, followed by a dehydration process at 40 °C for 48 hours using a SBT 10XL model tray from Peru. Finally, the dehydrated shells were subjected to a grinding process to obtain flour, thus ensuring a product of high quality and versatility.

Preparation of cookies with passion fruit peel flour enriched with anchovy protein concentrate.

The process begins with the reception and weighing of ingredients such as wheat flour with 237.5 g, protein concentrate 5 g, passion fruit peel flour 7.5 g, vegetable butter with 64.125 g, vanilla 0.625 g, brown sugar with 72.5 g, ammonium 1.65 g, sodium bicarbonate 0.85 g, table salt with 1.475 g and finally milk powder with 4.2 g. Then, creaming is done by combining butter, sugar, ammonium, vanilla essence and salt in a stainless steel mixer for 5-7 minutes until obtaining a foamy cream.

Creaming is done by combining butter, sugar, ammonium, vanilla essence and salt in a stainless steel mixer for 5-7 minutes until obtaining a foamy cream.

Afterwards, the shell flour is mixed passion fruit, manually for 10 minutes to prevent the dough from sticking.

It is then rolled out and shaped with a biscuit cutter before baking at 140 °C for 14 minutes in an electric oven.

After baking, the cookies are cooled for 10-15 minutes, labeled and they are packaged in polypropylegs,

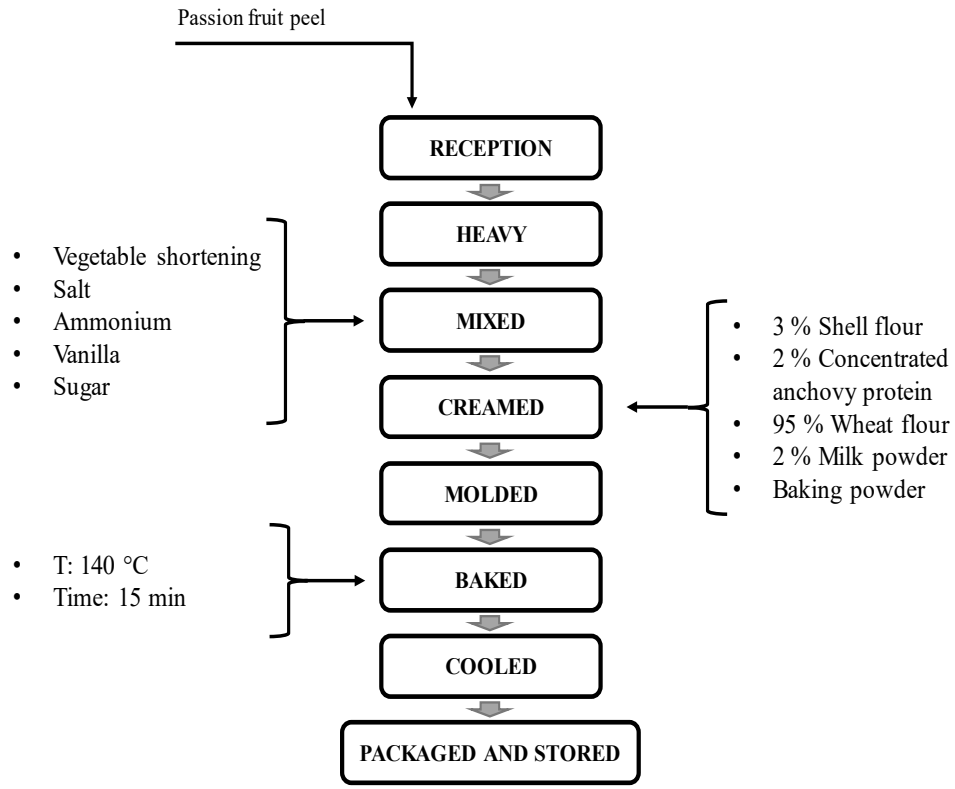

Figure 2. Block diagram for the preparation of cookies with passion fruit peel flour and enriched with protein concentrate

grouped in packages of 6 units and stored.

Formulation

In the execution of this investigation, concerning flour-type ingredients, three formulations were tested, Table 1:

Table 1.

Description of the flour formulations

Types of flour	Formulation		
	F1%	F2%	F3%
Wheat flour	95	95	95
Passion fruit flour peel	2.5	3	3.5
Anchovy protein concentrate	2.5	2	1.5

Satisfaction evaluation

In the pilot plant of the National University of Santa, a culinary project was carried out with the objective of making cookies, using passion fruit peel flour. To evaluate satisfaction, a study was carried out with the participation of 30 panelists from the professional school of Agroindustrial Engineering of the National University of Santa, the sensory quality of cookies was evaluated. The following were considered: aroma, flavor, texture and color, using a 4-point hedonic scale (not pleasant, not very pleasant, pleasant and very pleasant).

RESULTS AND DISCUSSION

Passion fruit peel flour

For the preparation of passion fruit peel flour, it was taken into account that humidity is associated with the drying process, being lower when the peels are dried using microwaves, however, the properties of color, protein, fiber, carbohydrates, fat and ash are not affected by the drying method or the type of cut (Meza & Zambrano, 2018). It is advisable to

generate a greater quantity of passion fruit peel flour during the months of maximum production, since availability decreases in July, August, September and November (Carrasco *et al.*, 2022).

Physico-chemical analysis of passion fruit peel flour (*Passiflora edulis*)

Passion fruit peel flour exhibits a notable crude fiber content, along with high percentages of proteins and carbohydrates (table 2), according to the nutritional information provided for 100 g.

Table 2.

Nutritional information of passion fruit peel flour in 100 g

Components	%
Humidity	11.25 ± 0.04
Protein	5.14 ± 0.01
Fat	0.60 ± 0.02
Ashes	4.93 ± 0.02
Carbohydrates	49.78
Crude fiber	28.33 ± 0.29

Source: Chuqui & Paucar (2021)

In the physical-chemical analysis of the passion fruit peel flour, (Table 2) the presence of protein 5.14 % carbohydrates stands out. 49.78 %, crude fiber 28.33 %, being low in (27.48 %) and carbohydrates (50.88 %), According to Vásquez (2018), pasion fruit shell flour has a value of 104.005 mg per 100 g, for total polyphenols, supporting the consistency of nutritional benefits. In different studies, in addition, a study carried out by Chuqui and Paucar (2021) concludes that these characteristics, which include water retention, oil adsorption capacity, tea, high fiber content, abundant polifenols, fat with 0.60 %. With these properties, it offers benefits and is useful in the food industry (Murillo *et al.*, 2023).

Likewise, Villanueva (2018) found similarities in the composition of passion fruit peel flour, with proteins (3.79 %), fat (0.39 %) and an outstanding antioxidant capacity, together with favorable values in terms of farinography, make passion fruit peel flour ideal as a raw material or substitute in the food industry. However, the incorporation of passion fruit peel flour modifies other characteristics of the physicochemical profile in other products, for example, by increasing the amount of this flour in a fruit drink, the functional compounds increase, which makes it a potentially nutritious food for consumers (Muñoz *et al.*, 2023). And in relation to the data provided by González and Martínez (2017), a comparison is presented that highlights the proximal chemical composition of the flour obtained from the passion fruit peel. These results reveal that the flour has the following percentages: protein (3.88 ± 0.10 %), humidity (12.04 ± 0.11 %), ash (4.81 ± 0.02 %), passion fruit fiber, carried out at different.

Analysis of vitamin C in passion fruit (*Passiflora edulis*) peel flour

The analysis of the amount of vitamin C present in the passion fruit peel flour is presented.

Table 3.

Analysis of vitamin C in passion fruit peel flour in 100

Passion fruit peel flour	mg
30 °C	6.16 ± 0.48
40 °C	4.48 ± 0.25
50 °C	4.18 ± 0.39

Source: Caballero & Escobedo (2019)

According to Caballero and Escobedo (2019), the analysis of vitamin C in the passion fruit peel flour revealed significant variations depending on the

drying temperature. It is observed that, at 30 °C, the highest value was obtained, reaching 6.16 mg, standing out as the sample with the highest vitamin C content among the three analyzed. This finding highlights the direct influence of temperature on the retention of essential nutrients during the drying process, underlining the importance of specific conditions to preserve the nutritional quality of the product.

Furthermore, Diaz & Flores (2018) analyzed the colorimetry of passion fruit peel flour, thus obtaining two values, one indicating a marked inclination towards the yellow color, possibly associated with the presence of carotenoids and polyphenols.

On the other hand, it indicates the hue angle towards the color red, located in the first quadrant of the color coordinates (red and yellow), registering a chromaticity value, or degree of pigmentation, of 36.129.

According to the study by Chuqui & Paucar (2021), the substitution of passion fruit flour in breads and cookies had a significant effect, especially when it exceeded 5 % in specific volume, ascorbic acid influenced the volume of the breads, but not in the cookie. Nutritionally, according to González and Martínez (2017), cookies have a significantly high fiber content, attributed to the abundant amount of fiber provided by the passion fruit peel.

Hydrolyzed anchovy protein concentrate

Table 4 presents the analysis of the hydrolyzed protein concentrate where the main component is protein with an amount of 80 mg, it can also be seen that it has a low fat index with 0.50 mg, it also presents phosphorus that contains 512.6 mg, as iron in 5.961 mg, potassium in the amount of 1139.2 mg and finally sodium in the amount of 913.6 mg. Furthermore, Roldán *et al*. (2021), states that anchovy protein hydrolyzate is rich in lysine, it is ideal for functional products, beneficial for child nutrition and development.

Microspheres in innovative foods protect the hydrolyzed protein with sodium alginate to avoid unwanted flavors and also enrich foods with concentrated substances such as extracts and oils, making them functional (Santamaria, 2023). Obtaining protein hydrolyzate is a good option for future production of innovative and functional ingredients in the food industry (Martínez, 2023).

Table 4.

Nutritional information of the hydrolyzed Anchovy protein concentrate in 100 g

Components	Results
Protein	80 g
Total fat	0.50 mg
Phosphorus	512.6 mg
Iron	5.961 mg
Potassium	1139.2 mg
Sodium	913.6 mg

Source: Colpex International SAC (2022)

Formulation

After the evaluation of the three flour formulations, formulation 2 was chosen, which is composed of: 95 % wheat flour, 3 % passion fruit peel flour because it had a pleasant flavor and good texture when consumed. and 2 % hydrolyzed protein concentrate because it does not affect the flavor of the cookies.

Degree of satisfaction

The evaluation of the cookie with passion fruit peel flour revealed a positive response in terms of its pleasantness. In relation to the aroma, the cookie was well

received, earning ratings ranging from "very pleasant" 81 % to simply "pleasant" 15 %. Furthermore, with regard to texture, the evaluations were consistent and mostly favorable, with the cookie being widely accepted and rated as "very pleasant" 64 % in this aspect (table 5).

Table 5.

Degree of satisfaction with cookies

Components	Aroma	Flavor	Texture	Color
Not at all pleasant	1 %	1 %	1 %	1 %
Not pleasant	3 %	4 %	5 %	2 %
Pleasant	15 %	40 %	30 %	25 %
Very pleasant	81 %	55 %	64 %	72 %

CONCLUSIONS

Cookies enriched with passion fruit peel and hydrolyzed protein concentrate have been obtained, representing a significant advance in the convergence between food science and food sustainability. This achievement highlights the ability to combine ingredients in innovative ways, providing products that are not only nutritious, but also environmentally sustainable. The preparation of these cookies, which incorporate passion fruit peel and hydrolyzed protein concentrate, has involved a meticulous and careful production process. During this process, rigorous quality standards have been met in terms of texture and sensory attributes. Passion fruit peel, enriched with protein, not only improves taste but also strengthens immune health. Additionally, the abundance of fiber in passion fruit peel supports digestive health, offering a sustainable energy source.

BIBLIOGRAPHICAL REFERENCES

Aguilar, S., Enrique, M., & Uvidia, H. (2022). Residuos agroindustriales: su impacto, manejo y aprovechamiento. *Revista científica de docencia, investigación y proyección social. 1 (27)*, 5-11. https://doi.org/10.26621/ra.v1i27.803

Caballero, M., & Escobedo, A. (2019). Actividad antioxidante de una bebida refrescante elaborado a partir de harina de cáscara de maracuyá (*Passiflora edulis*) [Tesis para el título de ingeniería, Universidad Nacional del Santa] Repositorio Institucional de la Universidad Nacional del Santa https://repositorio.uns.edu.pe/bitstream/handle/20.500.14278/3385/49225.pdf?sequence=1&isAllowed=y

Carrasco, A., Cruz, V., Flores, K., Pacherres, E., & Pérez, J. (2022). Diseño de una planta de producción de galletas elaboradas con harina de cáscara de maracuyá [Tesis para el título de ingeniería, Universidad de Piura]. Repositorio de la Universidad Nacional de Piura https://pirhua.udep.edu.pe/backend/api/core/bitstreams/05cd658f-dae5-40ce-8ff3-a845b8bde096/content

Castro, K. (2023). Elaboración de bloques nutricionales mediante el uso de diferentes niveles de harina de cáscara de maracuyá (*Passiflora edullis*) en la alimentación de conejos (*Oryctolagus cuniculus*) en la etapa de crecimiento [Tesis para el título de Medicina, Universidad Técnica de Babahoyo] Repositorio de la Universidad Técnica de Babahoyo http://dspace.utb.edu.ec/handle/49000/13961

Chung, J., Muro, N., Ontaneda, M., Palas, S., & Rodríguez, S. (2018). Diseño de una línea de producción para la elaboración de harina a base de la cáscara de maracuyá en quicornac S.A.C. Universidad de Piura. https://pirhua.udep.edu.pe/handle/11042/3829

Chuqui, S., & Paucar, L. (2021). Caracterización fisicoquímica, funcional y reológica de harina de cáscara de maracuyá (*Passiflora edulis* SIMS). *Revista de Investigación Científica Tayacaja 4*(2). 103-110. https://doi.org/10.46908/tayacaja.v4i2.177

Colpex International S.A.C (2022). Concentrado proteico de pescado tipo a – *Sabor Natural*. [Etiqueta].

Enemegio, K. (2023). Cáscara de pitahaya (*Hylocereus undatus*) como fuente de compuestos bioactivos en una galleta: fibra dietaría, propiedades antioxidantes y bioaccesibilidad de compuestos fenólicos [Tesis de Maestría en Ciencias de Nutrición, Universidad Autónoma de Nuevo León]. Repositorio de la Universidad Autónoma de Nuevo León http://eprints.uanl.mx/25434/

González, E., & Martínez, A. (2017). Sustitución parcial de la harina de trigo (*Triticum aestivum*) por la harina de kiwicha (*Amaranthus caudatus*) y la harina de cáscara de maracuyá (*Passiflora edulis*) en las características fisicoquímicas y sensoriales de galletas fortificadas. [Tesis para el título de ingeniería, Universidad Nacional del Santa] Repositorio Institucional de la Universidad Nacional del Santa https://repositorio.uns.edu.pe/bitstream/handle/20.500.14278/2989/42938.pdf?sequence=1&isAllowed=y

Lin, Y., Zheng, N., & Hsu, C. (2021). Torrefaction of fruit peel waste to produce environmentally friendly biofuel. *Science Direct*, 284,(124676). https://doi.org/10.1016/j.jclepro.2020.124676

López, L., Torres N., & Dávila L. (2021). Utilización de residuos del procesamiento de jugo de maracuyá (*Passiflora edulis*) para consumo humanos. *Revista Kawsaypacha, Sociedad y Medioambiente*, 8, 119-135. https://revistas.pucp.edu.pe/index.php/Kawsaypacha/article/view/24400/23170

Martínez, E. (2023). Caracterización y propiedades funcionales de hidrolizados proteicos obtenidos a partir de subproductos de la industria agroalimentaria [Tesis de Titulo, Universidad de Burgos]. Repositorio de la Universidad Burgos https://riubu.ubu.es/handle/10259/7495

Meza, J., & Zambrano, M. (2018). Efecto del corte y métodos de secado en las características fisicoquímicas de harina de cáscara de maracuyá (*Passiflora edulis flavicarpa*). [Tesis para el título de ingeniería, Escuela Superior Politécnica Agropecuaria de Manabí Manuel Félix Lopez]. Repositorio Dspace https://repositorio.espam.edu.ec/bitstream/42000/885/1/TTAI4.pdf

Montero, M. (2021). Hidrolizados proteicos a partir de subproductos de la industria pesquera: obtención y funcionalidad. *Agronomía Mesoamericana, 32*(2).681-699. https://doi.org/10.15517/am.v32i2.41437

Morales, D., Cano, J., & Londoño, N. (2019). Red inalámbrica de biosensores enzimáticos para la detección de contaminantes en aguas. *Revista Politécnica, 15*(29), 9–22. https://doi.org/10.33571/rpolitec.v15n29a1

Murillo, P., García, J., & Saltos, S. (2023). Néctar a base de pitahaya (*Hylocereus undatus*) con harina de cáscara de maracuyá (*Passiflora edulis flavicarpa*): Compuestos antioxidantes, estabilidad fisicoquímica y aceptabilidad sensorial. *Nutrición Clínica Dietética Hospitalaria, 43*(3), 63-73. https://doi.org/10.12873/433munoz

Pardavé, W., & Mendoza, P. (2023). Caracterización Físico-Química de la Cáscara De piña (*Ananas comosus*) Tipoperolera del Departamento de Santander. *Revista Politécnica, 19*(38), 143-159. https://doi.org/10.33571/rpolitec.v19n38a9

Prakash, N., Chandra, A., Shanker, A., Shah, K., Sajith Babu, K., Thorakkattu, P., Al Asmari, F., & Pandiselvam, R. (2023). Valorization of Fruit Waste for Bioactive Compounds and Their Applications in the Food Industry. *Foods*, 12,556. https://doi.org/10.3390/foods12030556

Rodríguez, D. & Muñoz, K. (2023). Modelo de negocios para empresas exportadoras de pitahaya. En Cuzme Espinales A. (Ed.) *Miradas Contextuales de investigación y cooperación interuniversitaria* (pp. 1-9.). Uleam Publicaciones y Servicios Bibliográficos.

Roldan, D., Omete, J., & Molleda, A. (2021). Elaboración de un hidrolizado de proteína de anchoveta (Engraulis ringens) en polvo. *Anales Científicos*. 82(2), 251-261. https://doi.org/10.21704/ac.v82i2.1787

Sadiku, M., Musa, S., & Ashalou, T. (2019). Food Industry: An Introduction. I*nternational Journal of Trend in Scientific Research and Development*, 3.128-130. https://doi.org/10.31142/ijtsrd23638

Sánchez, A., Torres, E., Espinoza, I., Montenegro, L., Barba, C., & García, A. (2019). Valoración nutricional in situ de dietas con harina de maracuyá (*Passiflora edulis*) en sustitución del maíz (*Zea mays*). Revista de Investigaciones Veterinarias del Perú, 30(1), 149-157. http://www.scielo.org.pe/scielo.php?script=sci_arttext&pid=S1609-91172019000100015&lang=es

Santamaria, J. (2023). Enriquecimiento del bizcocho chancay con cápsulas de proteína hidrolizada de anchoveta (*Engraulis ringens*) [Tesis de Maestría, Universidad Nacional Federico Villareal] Repositorio de la Universidad Nacional Federico Villareal. https://repositorio.unfv.edu.pe/handle/20.500.13084/6973

Vásquez, P. (2018). Efecto de la sustitución parcial de harina de trigo (*Tríticum aestivum*) por harina de cáscara de maracuyá (*Passiflora edulis*) y harina de quinua (*Chenepodium quinoa w.*) en las características tecnológicas y sensoriales de cupcake. [Tesis para el título de ingeniería, Universidad Nacional del Santa]. Repositorio Institucional de la Universidad Nacional del Santa https://repositorio.uns.edu.pe/bitstream/handle/20.500.14278/3235/48917.pdf?sequence=1&isAllowed=y

Villanueva, J. (2018). Efecto de la sustitución parcial de harina de trigo (*Triticum aestivum*) por harina de cáscara de maracuyá (*Passiflora edulis*) y harina de camote (*Ipomoea batatas*) en las características tecnológicas y sensoriales del cupcake [Tesis para el título de ingeniería, Universidad Nacional del Santa]. Repositorio Institucional de la Universidad Nacional del Santa https://repositorio.uns.edu.pe/bitstream/handle/20.500.14278/3115/47239.p

Yupanqui, M. (2020). Efecto del ácido fosfórico y tiempo de hidrólisis en la obtención de azúcares reductores de harina de cáscara de maracuyá (*Passiflora edulis*). [Tesis para el título de ingeniero, Universidad Nacional de Trujillo]. Repositorio de la Universidad Nacional de Trujillo https://dspace.unitru.edu.pe/server/api/core/bitstreams/9361af4f-e835-47e0-a053-6bef95348a32/content