



## Market analysis of rice-based products and election of consumers targets

[ 01-09-2021 ]



TRACE-RICE with Grant n° 1934, is part of the PRIMA Programme supported under Horizon 2020, the European Union's Framework Programme for Research and Innovation



**PRIMA**  
PROGRAMME FOR RESEARCH AND INNOVATION  
IN THE MEDITERRANEAN AREA



## TECHNICAL REFERENCES

<b>Project Acronym</b>	TRACE-RICE
<b>Project Title</b>	
<b>Project Coordinator</b>	Carla Moita Brites <a href="mailto:carla.brites@iniav.pt">carla.brites@iniav.pt</a>
<b>Project Duration</b>	September 2020 –August 2024 (48 months)
<b>Deliverable No.</b>	D3.1
<b>Dissemination level*</b>	PUBLIC
<b>Work Package</b>	WP 3 - Coordination
<b>Task</b>	T3.1 – Market analysis of rice-based products and election of consumers targets
<b>Lead beneficiary</b>	CSIC-IATA
<b>Contributing beneficiary/ies</b>	INIAV, DPL
<b>Due date of deliverable</b>	1 March 2022
<b>Actual submission date</b>	4 August 2021

	Date	Beneficiary	Author
V1	02/08/2021	CSIC-IATA	Cristina M. Rosell
V2	21/09/2021	INIAV	Carla Brites
V1	22/09/2021	DPL	Joaquin Salvo
			Approved by
V3	04/10/2021	INIAV	Carla Brites

## TABLE OF CONTENTS

---

<b>1. PURPOSE</b>	<b>4</b>
<b>2. RICE GLOBAL CONSUMPTION</b>	<b>4</b>
<b>1 RICE: INNOVATIONS IN A TRADITIONAL CEREAL</b>	<b>5</b>
1.1 RICE BEVERAGES AND VINEGARS	6
1.2 SNACKS, COOKIES, BREAKFAST CEREALS AND PUFFED RICE	7
1.3 PLANT-BASED DRINKS AND MEAT ANALOGS	8
1.4 WHOLEGRAIN BROWN RICE PRODUCTS AND INNOVATION	8
1.4.1 <i>Improving wholegrain brown rice products</i>	9
1.4.2 <i>Strategies to improve WBR products</i>	10
1.4.2.1 Bioprocess techniques and enzymatic approaches	10
1.4.2.2 Other wholegrain brown rice-based strategies	10
<b>2 FINAL REMARKS</b>	<b>11</b>
<b>3 CONCLUSION</b>	<b>11</b>
<b>4 REFERENCES</b>	<b>12</b>

## FIGURES INDEX

---

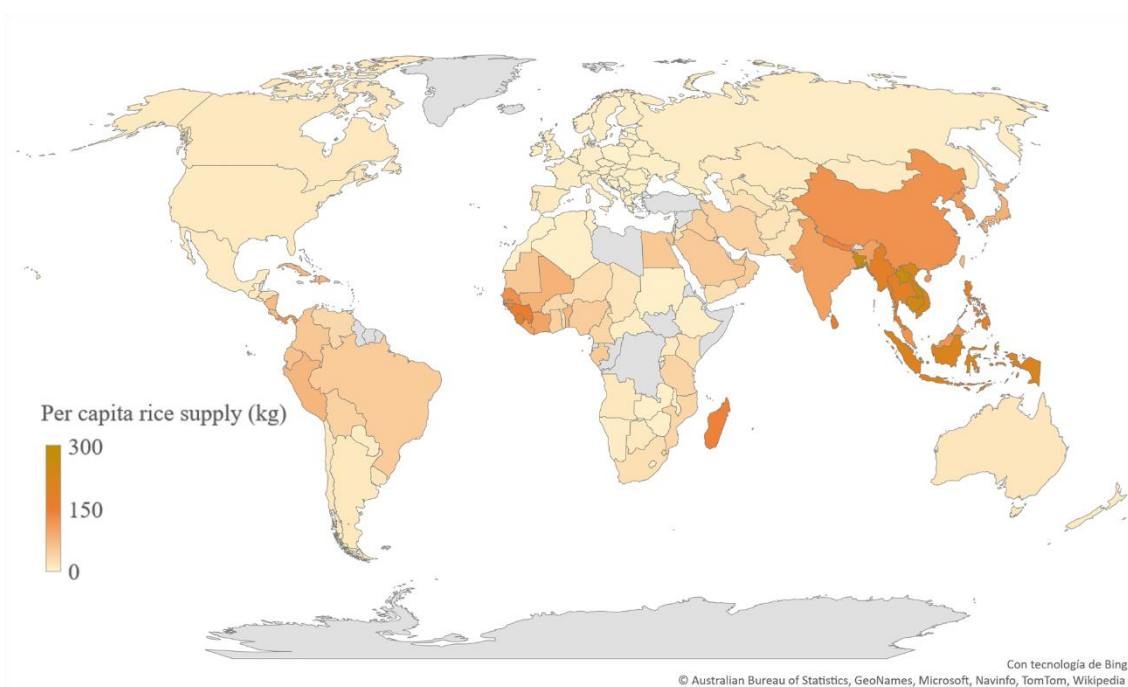
<b>Figure 1.</b> Average per capita rice consumption, in kilograms per person per year Source: data adapted from (Our World in Data, 2016). .....	4
<b>Figure 2.</b> Rice-based products available on the global market currently. ....	6
<b>Figure 3.</b> Current challenges and related strategies for wholegrain brown rice (WBR) in (Xia et al., 2019). .....	10

## 1. Purpose

To know the existing foods containing rice as main or secondary ingredient was carried out an analysis of the global market of rice containing products. This analysis could serve as starting point for selecting the targeted foods to innovate using rice ingredients. Marketed products were identified in the main international malls and after analysing their composition and processing they were categorized in different groups.

## 2. Rice global consumption

Rice (*Oryza sativa* L.) is a worldwide staple food, being a major ingredient for more than half of the world's population. Rice can be classified in two different subspecies: *indica* (shorter and round grains, with lower amylose content and sticky after cooking) and *japonica* (longer grains, with higher amylose content and fluffy after cooking) (Park, Lee, & Choi, 2017). Concerning rice processing method, the polished white rice is the most consumed all over the world (**Figure 1**). Rice consumption has undergone a slight increase in recent years, reaching 504.3 tons millions consumption in 2020/2021, meaning an increase of 15% compared with 2008/2009 (STATISTA, 2021). In Asian countries, delivers more than 75% of daily calorie consumption (Park et al., 2017) and 15% at worldwide level. In Africa and Latin America its consumption is increasing due to changes in eating habits. In addition, the growing interest in Asian foods is also encouraging this increase in other areas of Europe, United States or Australia (Bao, 2016).



**Figure 1.** Average per capita rice consumption, in kilograms per person per year Source: data adapted from (Our World in Data, 2016).

## 1 Rice as a traditional cereal

---

The importance of rice in the Mediterranean cuisine is well documented in the huge collection of in-house recipes and in-country traditions. From these information, three Mediterranean traditional culinary types were identified: i) risotto- rices that excel at forming a rich, creamy broth while maintaining the integrity of individual grains that are soft to the tooth but don't dissolve completely; ii) paella- short grain that release enough starch to form a crispy crust on the bottom of the pan, yet when cooked in an open vessel with plenty of air circulation, they retain a toothy texture; iii) carolino- long grain that easily absorbs stock or water from the boiling, retained all the added flavours.

The global picture of consumers in Europe is largely affected by the net incoming migration and the increasing interest of the population for more ethnic cuisine and its ingredients. To face the actual consumer's expectations other non-traditional culinary types should be considered such as the aromatic (e.g basmati and jasmine) or sushi rice. Currently consumer preferences are scarcely driven by rice variety, and only in a few cases the selection of the variety is made based on the culinary application. This is the case of rice for sushi, consumers prefer rice with sticky and chewy texture, such as the traditional Japanese variety *Koshihikari* (Okadome, 2005). While for risotto the main selected varieties are *Baldo* or *Arborio* rice, short grains with high amylopectin which releases starch during cooking making a creamy and smooth risotto (Mohapatra & Bal, 2006). Nevertheless, the extended differences in the rice features depended on varieties and their different performance in culinary applications, points out the importance of including rice varieties information to conduct consumers preference based on varieties and not just size of rice, brown/polished, color and so on.

Therefore, there is limited connection between rice varieties and final applications. Because of that the project will pursue to implement the varieties selected in WP1 into the most appropriate applications.

## 2 Rice: Innovations in a traditional cereal

---

Rice grain is one of the most important ingredients used to produce ready-to eat products. However, owing to its versatility, the use of rice (grain or flour) as one of the main ingredients in products has increased. The number of rice-based products available in markets is rising, probably due to both the increase in consumers interest in innovative and healthy products and the internationalization of the food industry. In this point, it should be stressed the importance of safety in fresh rice-based foods, because of that microbial contamination and packaging are crucial points to be considered when designing innovations. However, those aspects exceed the goal of the present deliverable and are the objectives of WP2 of this project.

Currently, there are hundreds of rice-based products in the global market (**Figure 2**), and they can be classified as follows: crackers, thin cracker, cookies, baby food, desserts, drinks, vinegars, snacks, breakfast cereals, etc. Rice presents a very important role in all the listed products, since is the main ingredient. About 70% of the products have more than 50% of rice in their composition. According to information from manufacturers, the rice varieties more frequently used is *japonica* sub-specie. It

is well known that starch is the principal component of rice, and the selection of that rice variety mainly depends on the amylose/amylopectin ratio. For example, waxy rice is used chiefly for making sweets and desserts. On the other hand, to obtain baby food, beer or breakfast cereals, medium-grain rice with low amylose content (12-20%) is used. High amylose content rice (>25%) is majorly utilized to produce extruded rice noodles (Juliano & Hicks, 1996). Finally, for making rice cakes, cookies, etc., flours from any type of rice are used but the selection of rice variety implies different product characteristics.



**Figure 2.** Rice-based products available on the global market currently.

## 2.1 Rice beverages and vinegars

Rice is the main substrate for Japanese rice wine, *shake*. For its preparation rice flour, generally with fine particle size, is subjected to different fermentation processes. However, there are more rice-based drinks, like beers, other wines such as the one consumed in Taiwan, sweet liqueurs (rice liquor), etc. Production is similar to those made with other cereals, except in the case of liquors. To obtain them, the process starts with the water obtained after cooking and draining the rice, then alcohol (gin, vodka or similar) is added. In addition, in the market there are white, black or red rice vinegar, depending on the rice used. It is a traditional Japanese and Chinese product obtained from rice wine and subsequent fermentation for the transformation of alcohol into acetic acid.

## 2.2 Snacks, cookies, breakfast cereals and puffed rice

Breakfast cereals made from rice are widely known and consumed. These include rice flakes and puff rice and can be consumed directly. There are different processes to obtain breakfast cereals. The most common method starts with puffed rice (high temperatures for a few seconds) and then extrusion or baking. Other rice-based foods include cookies, widely consumed in Asian countries and they are getting very popular in other areas because they offer gluten-free alternatives for people with celiac disease. Rice cookies are traditionally made from rice paste (rice grain smashed after cooking) and finally moulded and baked. Nevertheless, currently rice flour is preferred for making cookies. In addition, in recent years the demand for snacks such as rice puffed cakes or bars have increased.

The most important success of these products lies in their versatility to incorporate other cereals, fruits, berries, legumes, etc. and the possibility of modifying raw materials through different processes that allow to improve their nutritional quality or taste. For instance, Arribas, Cabellos, Cuadrado, Guillamón, and Pedrosa (2019a) studied the effect of the extrusion process in bioactive compounds (inositol phosphates,  $\alpha$ -galactosides, protease inhibitors, lectins and phenolic compounds) and antioxidant capacity of different gluten-free expanded products based on rice, carob fruit and pea. The results shown that blends based on rice and legumes (carob fruit and pea) can deliver bioactive compounds in products such as snacks or breakfast cereals-like products, contributing to develop healthy and functional foods. These authors also concluded that extrusion process affects the different bioactive compounds in a distinctive level, and at the same time reduces phytic acid and lectins contents. In addition, extrusion increased total galactosides and phenolic compounds, and eliminated protease inhibitors. According to Arribas et al. (2019a), the developed rice-based products (in particular the formulation with 50% rice, 40% pea, 10% carob fruit), after extrusion process, presented a content of bioactive compounds, that can be considered as functional food, and in addition, contributes to rise legumes consumer's intake. In another research, Arribas, Cabellos, Cuadrado, Guillamón, and Pedrosa (2019b), developed also a rice-based ready-to-eat product, fortified with bean flour and carob fruit flour, obtaining promising results in what is concerned to nutritional profile and functional properties, when compared to other products prepared in exclusive with rice. The authors studied the effect of extrusion in final product nutritional composition, dietary fiber and starch contents. The results showed lower fat content, and balanced protein profile due to rice and legume flours combination. Extrusion process improved protein *in vitro* digestibility and soluble dietary fraction. The blends of rice, bean and carob can be considered good sources of fibre and protein, being recognized as healthy foods when considering USDA recommendations.

In order to obtain new products, it is not always necessary to combine with other ingredients or modify the processes. Applying known technologies to different less investigated rice varieties, allows to obtain innovative and quality products. Such is the case of Meza et al. (2019) that developed an innovative product, based on 100% extruded whole black and red milled rice flours, with the objective of obtaining gluten free natural colored breakfast cereals. Temperature and feed moisture combination effects were studied.

## 2.3 Plant-based drinks and meat analogs

The rise in the consumption of healthy products and the greater interest in animal welfare have made plant-based products a daily alternative for animal derived products, such as meat or milk. Rice drink is the most popular milk alternative after soy or almond drinks. For its preparation rice flour is used and it is described as a low-fat milk, rich in nutrients and minerals, and with good digestibility. In addition, in recent years, the strategies to increase or improve the properties of rice beverage have increased, either fortifying it or by previous modification of the grain to use it as probiotics carriers (Rasika et al., 2020). Meat analogs refer to food products made from non-meat ingredients but providing meat-like appearance, texture, flavor and mouthfeel. The main sources of protein used for developing this type of product have been those obtained from soybeans or wheat gluten (Bohrer, 2019; Malav, Talukder, Gokulakrishnan, & Chand, 2015). Rice is an alternative that reduce allergenicity problems of other vegetable proteins, although it presents different technological difficulties due to their proteins properties (Bohrer, 2019). However, there are already alternatives in the market, such as those shown in Figure 2 and Annex 1, where rice is present as one of the main ingredients and also is used to obtain products similar to fresh cheese or yogurts.

## 2.4 Wholegrain brown rice products and innovation

Regarding rice processing method, the polished white rice (WR) is the most consumed all over the world. Nevertheless, it has been found a positive correlation between its intake and type 2 diabetes incidence (Hu, Pan, Malik, & Sun, 2012; Nakayama et al., 2017). According to Boers, Ten Hoorn, and Mela (2015), there are considerable changes in rice glycaemic and insulinemic responses, depending on its characteristics and processing methods, rice subspecies and its intrinsic characteristics (amylose vs amylopectin), post-harvest processing (particularly parboiling), and consumer processing (cooking, storage and reheating).

Consequently, in the last years, more attention has been given to wholegrain brown rice (WBR), containing endosperm, germ and bran, trying to increase the ingestion of this alternative non-polished rice, since many studies sustain that it is a healthier choice, when compared to white rice (Nakayama et al., 2017; Zhang et al., 2010). This is due to its high content of nutrients such as protein, fat, minerals, and vitamins. Furthermore, WBR presents bioactive compounds (in the outer bran layer) with potential health benefits: anti-diabetic, antioxidant, and anticancer effects. Hence, WBR, germinated WBR and its processed products are expected to be healthier and reduce the prevalence of chronic diet-related diseases, than those from WR; being an alternative ingredient to develop functional and healthy foods. Nevertheless, WR is preferred by consumers, due to its taste, appearance, and texture when compared with WBR (Saleh, Wang, Wang, Yang, & Xiao, 2019).

In order to increase wholegrain brown rice consumption, food industry has performed different studies to analyse the capacity of rising the proportion of WBR in manufacturing of common food products, such as: noodles, bread, pasta, cakes, snacks, pastry, and beverages, developing new recipes with WBR in exclusive or with a share of WR and/or other ingredients (Cornejo & Rosell, 2015; Saleh et al., 2019).

Nevertheless, there are restrictions and challenges in the incorporation of WBR, due to its poorer sensory characteristics. The lower consumer acceptability of WBR, particularly in comparison with the WR can be attributed to different reasons (Gujral & Kumar, 2003; Lanning & Siebenmorgen, 2011; Mohan et al., 2017; Mojica & Grace, 2010; Monge-Rojas, Mattei, Fuster, Willett, & Campos, 2014; Saleh et al., 2019; Wang, Wu, Li, Yang, & Shi, 2011). Among them it could be highlighted:

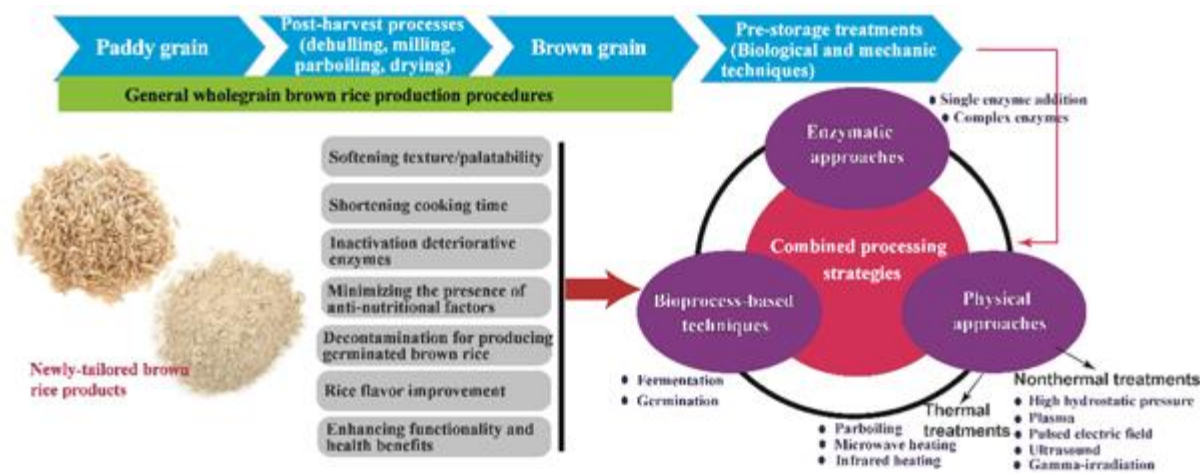
- Its higher fiber content, and phenolic compounds cause astringent taste, and is perceived a harder texture and chewing palatability together with a dark colour.
- Longer cooking time and poor water absorption.
- Greater susceptibility to oxidation and off-flavour development, due to its high oil level in the out-bran layer, with a consequent shorter shelf-life at room temperature storage.
- Anti-nutritional compounds (e.g., phytic acid and tannin).
- Unawareness of WBR health benefits among average consumers and common preference for refined products.

Alternatively, considering that WR is the most frequently consumed type of rice, a large amount of high nutritional-value sub-products are generated during milling, which could be the source of bioactive compounds and also healthy food ingredients (Park et al., 2017). Within those, it must be highlighted the under-explored rice bran oil, which has a very attractive fatty acids profile and high amount of  $\gamma$ -oryzanol, apart from the technological advantages for having high smoked point that extends the potential industrial applications. Focus on the fibers from rice bran could be also an interesting part to be explored. For instance, Sunfiber® is a dietary fiber rich product obtained from rice by-products that could increase the fiber content of bakery products. Despite the nutritional benefits and the potential technological impact of this ingredient, some research will be needed to extend its application in bakery products, that will be undertaken in WP3 of the present project.

#### 2.4.1 Improving wholegrain brown rice products

Accordingly, the development of innovative rice products should be focused in promoting WBR use instead of WR. However, what makes the WBR healthier, is exactly the main cause responsible for the reduction in palatability and acceptance by the consumer, because of this reason it is so important to find innovative technological solutions to overcome all the referred negative perceived characteristics, in order to improve WBR-based products with good sensory qualities (Saleh et al., 2019).

In a review work, Xia et al. (2019), focused on the effects of innovative process technologies in wholegrain brown rice quality, and functional characteristics when compared with traditional methods, underlined the advantages of combining processing and pre-treatments techniques in WBR quality and functional characteristics. The authors prepared a presentation of their findings in a schematic figure (**Figure 3**), where strategies to improve WBR quality, sensorial, nutritional and functional properties are clearly summarized.



**Figure 3.** Current challenges and related strategies for wholegrain brown rice (WBR) in (Xia et al., 2019).

## 2.4.2 Strategies to improve WBR products

### 2.4.2.1 Bioprocess techniques and enzymatic approaches

Wholegrain brown rice fermentation or germination are used as an additional process, to improve the usage of bioactive compounds in the grains, to produce WBR-based foods, such as beverages, yogurt-like, porridges, vinegar or bread. Fermented WBR products have several protective and therapeutic effects (Kuno et al., 2015). In their review, Xia et al. (2019) summarized the used fermenting strains for different authors: yeast, lactic acid bacteria (LAB), *Monascus* sp. and *Aspergillus oryzae*. During WBR fermentation process, microorganisms are responsible for metabolic activities and enzymatic transformations, increasing bioavailability of micronutrients, in parallel with anti-nutritional factors reduction. Furthermore, specific positive effects are referred to occur with fermentations at moderate acidity (pH 5-6): increasing protein, fiber, minerals, resistant starch, phenolic compounds, antioxidant activity, and vitamins B and E, together with phytate decrease. Germination has been demonstrated to be a strategy to improve textural and organoleptic quality, nutrient and phytochemical bioavailability and biological activity. Cáceres, Peñas, Martínez-Villaluenga, García-Mora, and Frías (2019) demonstrated the suitability of germinated brown rice to improve the bioactive compounds (phenolic compounds and GABA) and technological properties in yogurt-like products. Moreover, rice flour germinated during 24 h also led to improve rice bread texture, showing the appropriate functionality for being used as raw ingredient in breadmaking (Cornejo & Rosell, 2015). The enzymatic approaches have been aimed largely as a pre-treatment of rice bran, nevertheless some studies suggest that adding enzymes during milling could modify the technological and nutritional quality of cooked brown rice grain (Das, Banerjee, & Bal, 2008) or improve the cookies texture when enzymes were added during the process (Dang, Therdthai, & Ratphitagsanti, 2018). All these techniques have demonstrated to be an alternative to improve brown rice products, thus rise the consumers acceptance.

### 2.4.2.2 Other wholegrain brown rice-based strategies

As it has been mentioned for white rice, one of the most used strategies to improve the acceptance of products with WBR is the combination of this with other fruits, legumes, etc. An example of this was the study carried out by Mir, Bosco, Shah, Santhalakshmy, and Mir (2017). They studied apple pomace effect on physicochemical and antioxidant

properties of WBR crackers. Crackers were prepared adding 0, 3, 6, or 9% apple pomace to WBR flour. The results have shown a rising in antioxidant activity, total dietary fiber, and minerals; whereas cracker's overall acceptability and lightness diminished as the apple pomace incorporation increased. Moreover, Mir, Bosco, and Shah (2019) developed an innovative fried snack, mixing WBR flour with chestnut flour with the following ratios (WBR flour/chestnut flour): 100/0, 80/20, 60/40, and 40/60, respectively. The snacks were rich in potassium, phosphorus, sulphur, and magnesium.

### 3 Final remarks

---

It is important to stress that consumers in general have a lack of knowledge about WBR health benefits, and the correlation between its consumption and well-being. Therefore, communication is crucial to assure the success of new marketed products (Monge-Rojas et al., 2014).

Also a fundamental aspect is the fact that WBR has higher price when compared to WR, since WBR is produced at small-scale, owing to its lower demand in comparison to WR. Moreover, due to the high oil level in the outer bran layers of WBR, the prevention of rancidity during handling and storage might cause an extra cost (Mohan et al., 2017). With the aim of increasing shelf-life and product stability of WBR, cost-efficient processing and packaging techniques are also important to develop. Thus, it is necessary to find solutions that contribute to WBR production cost reduction, in order to promote its utilization among consumers (Saleh et al., 2019).

Another benefits that might occur with the increase of WBR consumption, and thus WR reduction, are related to economic and environmental positive effects. Specifically, the reduction of rice milling costs, since polishing or whitening stages will be removed from the process, together with the decrease of time and energy consumption (Mojica & Grace, 2010).

### 4 Conclusion

---

Innovative rice-based products development is increasing, and many are reaching the market. Formulations should be developed using combined processes to improve WBR characteristics, together with blends of other ingredients, in order to contribute to balance sensorial characteristics and nutritional profile. Some scientific research has been performed in different types of products, with the aim of assessing its quality and testing different effects on processing methods. Promising results have been achieved but further research is needed for the development of each specific new rice-based product.

#### Methodology for the benchmarking

During the Market Revision 200 products were found. The search for the products was performed using following methodology:

- The keyword rice was used in the search areas of the different online shops;

- Supermarkets from Portugal, Spain, France and England were screened through the on-line shop channel. Specifically: Continente, El Corte Inglés, Carrefour, Tesco and Whole Foods Market;
- The online shopping websites: Amazon, Naturitas, Vitalifehealth, Shopkindly;
- Websites of the products manufacturers: Eduard & Sons, Fantastic, Gullon;
- When using the search engine “Google”, the keywords rice, rice products, innovative rice products were selected;
- The products were divided into 10 categories, according to their types;
- When similar products were found, only one was considered;
- Products of the same brand, with different flavours/types were all listed.

## 5 References

---

- Arribas, C., Cabellos, B., Cuadrado, C., Guillamón, E., & Pedrosa, M. M. (2019a). The effect of extrusion on the bioactive compounds and antioxidant capacity of novel gluten-free expanded products based on carob fruit, pea and rice blends. *Innovative food science & emerging technologies*, 52, 100-107.
- Arribas, C., Cabellos, B., Cuadrado, C., Guillamón, E., & Pedrosa, M. M. (2019b). Extrusion effect on proximate composition, starch and dietary fibre of ready-to-eat products based on rice fortified with carob fruit and bean. *LWT*, 111, 387-393.
- Bao, J. S. (2016). Rice: Eating Quality. In C. Wrigley, H. Corke, K. Seetharaman, & J. Faubion (Eds.), *Encyclopedia of Food Grains (Second Edition)* (pp. 166-175). Oxford: Academic Press.
- Boers, H. M., Ten Hoorn, J. S., & Mela, D. J. (2015). A systematic review of the influence of rice characteristics and processing methods on postprandial glycaemic and insulinaemic responses. *British Journal of Nutrition*, 114(7), 1035-1045.
- Bohrer, B. M. (2019). An investigation of the formulation and nutritional composition of modern meat analogue products. *Food Science and Human Wellness*, 8(4), 320-329.
- Cáceres, P. J., Peñas, E., Martínez-Villaluenga, C., García-Mora, P., & Frías, J. (2019). Development of a multifunctional yogurt-like product from germinated brown rice. *LWT*, 99, 306-312.
- Cornejo, F., & Rosell, C. M. (2015). Influence of germination time of brown rice in relation to flour and gluten free bread quality. *Journal of Food Science and Technology*, 52(10), 6591-6598.
- Dang, L. T. K., Therdthai, N., & Ratphitagsanti, W. (2018). Improvement of structure and cooking quality of brown rice using ultrasonic and enzymatic treatments. *Journal of Food Processing and Preservation*, 42(11), e13814.
- Das, M., Banerjee, R., & Bal, S. (2008). Evaluation of physicochemical properties of enzyme treated brown rice (Part B). *LWT-Food Science and Technology*, 41(10), 2092-2096.
- Gujral, H. S., & Kumar, V. (2003). Effect of accelerated aging on the physicochemical and textural properties of brown and milled rice. *Journal of Food Engineering*, 59(2-3), 117-121.
- Hu, E. A., Pan, A., Malik, V., & Sun, Q. (2012). White rice consumption and risk of type 2 diabetes: meta-analysis and systematic review. *Bmj*, 344.
- Juliano, B. O., & Hicks, P. A. (1996). Rice functional properties and rice food products. *Food Reviews International*, 12(1), 71-103. doi:10.1080/87559129609541068
- Kuno, T., S. Takahashi, H. Tomita, K. Hisamatsu, A. Hara, A. Hirata, H. Kobayashi, H. Mori. (2015). Preventive effects of fermented brown rice and rice bran against N-nitrosobis (2-oxopropyl) amine-induced pancreatic tumorigenesis in male hamsters. *Oncology Letters*, 10 (6):3377–84.
- Lanning, S., & Siebenmorgen, T. (2011). Comparison of milling characteristics of hybrid and pureline rice cultivars. *Applied Engineering in Agriculture*, 27(5), 787-795.
- Malav, O., Talukder, S., Gokulakrishnan, P., & Chand, S. (2015). Meat analog: A review. *Critical Reviews in Food Science and Nutrition*, 55(9), 1241-1245.

- Meza, S. L. R., Sinnecker, P., Schmiele, M., Massaretto, I. L., Chang, Y. K., & Marquez, U. M. L. (2019). Production of innovative gluten-free breakfast cereals based on red and black rice by extrusion processing technology. *Journal of Food Science and Technology*, 56(11), 4855-4866.
- Mir, S. A., Bosco, S. J. D., & Shah, M. A. (2019). Technological and nutritional properties of gluten-free snacks based on brown rice and chestnut flour. *Journal of the Saudi Society of Agricultural Sciences*, 18(1), 89-94.
- Mir, S. A., Bosco, S. J. D., Shah, M. A., Santhalakshmy, S., & Mir, M. M. (2017). Effect of apple pomace on quality characteristics of brown rice based cracker. *Journal of the Saudi Society of Agricultural Sciences*, 16(1), 25-32.
- Mohan, V., Ruchi, V., Gayathri, R., Bai, M. R., Shobana, S., Anjana, R., Sudha, V. (2017). Hurdles in brown rice consumption *Brown rice* (pp. 255-269): Springer.
- Mohapatra, D., & Bal, S. (2006). Cooking quality and instrumental textural attributes of cooked rice for different milling fractions. *Journal of Food Engineering*, 73(3), 253-259.
- Mojica, L. E., & Grace, R. M. (2010). An exploratory market study of brown rice as a health food in the Philippines.
- Monge-Rojas, R., Mattei, J., Fuster, T., Willett, W., & Campos, H. (2014). Influence of sensory and cultural perceptions of white rice, brown rice and beans by Costa Rican adults in their dietary choices. *Appetite*, 81, 200-208.
- Nakayama, T., Nagai, Y., Uehara, Y., Nakamura, Y., Ishii, S., Kato, H., & Tanaka, Y. (2017). Eating glutinous brown rice twice a day for 8 weeks improves glycemic control in Japanese patients with diabetes mellitus. *Nutrition & diabetes*, 7(5), e273-e273.
- Okadome, H. (2005). Application of instrument-based multiple texture measurement of cooked milled-rice grains to rice quality evaluation. *Japan Agricultural Research Quarterly: JARQ*, 39(4), 261-268.
- Our World in Data. (2021, 06 21). Retrieved from <https://ourworldindata.org/grapher/rice-consumption-vs-latitude?minPopulationFilter=1000000>
- Park, H.-Y., Lee, K.-W., & Choi, H.-D. (2017). Rice bran constituents: immunomodulatory and therapeutic activities. *Food & Function*, 8(3), 935-943.
- Rasika, D., Vidanarachchi, J. K., Rocha, R. S., Balthazar, C. F., Cruz, A. G., Sant'Ana, A. S., & Ranadheera, C. S. (2020). Plant-based milk substitutes as emerging probiotic carriers. *Current Opinion in Food Science*.
- Saleh, A. S., Wang, P., Wang, N., Yang, L., & Xiao, Z. (2019). Brown rice versus white rice: Nutritional quality, potential health benefits, development of food products, and preservation technologies. *Comprehensive Reviews in Food Science and Food Safety*, 18(4), 1070-1096.
- STATISTA. (2021, 07 26). Retrieved from <https://www.statista.com/statistics/255977/total-global-rice-consumption/>
- Wang, K. M., Wu, J. G., Li, G., Yang, Z. W., & Shi, C. H. (2011). Distribution of phytic acid and mineral elements in three indica rice (*Oryza sativa* L.) cultivars. *Journal of Cereal Science*, 54(1), 116-121.
- Xia, Q., Green, B. D., Zhu, Z., Li, Y., Gharibzahedi, S. M. T., Roohinejad, S., & Barba, F. J. (2019). Innovative processing techniques for altering the physicochemical properties of wholegrain brown rice (*Oryza sativa* L.)—opportunities for enhancing food quality and health attributes. *Critical Reviews in Food Science and Nutrition*, 59(20), 3349-3370.
- Zhang, G., Malik, V. S., Pan, A., Kumar, S., Holmes, M. D., Spiegelman, D., Lin, X., Hu, F. B. (2010). Substituting brown rice for white rice to lower diabetes risk: a focus-group study in Chinese adults. *Journal of the American Dietetic Association*, 110 (8):1216–21.

**This deliverable has been disseminated through the following publication:**

**Garzon, R., Beltrão Martins, R., Brites, C., Rosell, C.M. 2021. Arroz: Innovaciones en un cereal tradicional. Revista Granos. Numero Julio-Agosto, pp 21-24.**

# Trace RICE



## TRACE-RICE Consortium



**IBET**  
Instituto de Biologia  
Experimental e Tecnológica



UNIVERSIDADE  
**NOVA**  
DE LISBOA



CASA DO  
ARROZ



ernesto  
morgado  
desde 1900



MATER  
DYNAMICS



Grupo Desarrollo



Instituto de Agroquímica  
y Tecnología de Alimentos



ALEXANDRIA  
UNIVERSITY