



Review article

Food Technology forecasting: A based bibliometric update in functional chocolates

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ABSTRACT

Technology forecasting (TF) based on bibliometric tools allows knowing the technological trends of developed topics based on experience and current knowledge, thus anticipating future changes. To reduce hunger and improve nutrition, the food-based topic is of central concern, especially functional food. Among these, various studies on chocolates have been performed. On a global scale, these products are at the level of patents, with China leading it, vastly outperforming the cocoa-producing countries. Though no known functional chocolates are sold under that specific name, chocolates on the market serve as "carriers" of bioactive compounds. Unfortunately, they cannot be attributed to health properties since these properties have to be evaluated with *in vitro*, *in vivo*, and clinical studies. Launching functional chocolate on the market is possible; however, it would be a long-term process involving previous stages such as studying its ingredients' bioactive properties, laboratory-level product development, functional properties, and quality and acceptance parameters. For research purposes, it is possible to speak of functional chocolates, potentially functional chocolates, or chocolates enriched with bioactive compounds since the development of research does not necessarily involve launching the product on the market.

1. Introduction

Technology forecasting (TF) is a dynamic, selective, and permanent process to capture information from outside and inside

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technological development. It involves finding, extracting, selecting, analyzing, adding value, and disseminating information [1]; it is increasingly used worldwide to predict the daily requirements of the "market," providing organizations with current knowledge in a more effective response time [2,3]. It is necessary to highlight that this activity is within the ethical and legal framework and should not be confused with espionage [4,5] and can be developed in different areas. For example, the Colombian education sector [6] proposes using TF as a tool for an industrial engineering program and prospective and dynamic curriculum design. Pineda [7] conducted TF to identify the food industry's main innovation factors (clients, providers, research institutes, and universities).

On the other hand, bibliometric studies are used to develop TF; Hernández [8] analyzed the use of Big Data technologies in the insurance sector; Lebelo et al. [9] promoted the collaboration on food safety research between developing countries; Kreuchauff & Korzinov [10] used bibliometrics and patent analysis to assess trends in various sectors evaluating available emerging technologies within scientific research; Chen et al. [11] consolidated the state-of-the-art food waste research based on a bibliometric study.

In recent years, the problem of human health improvement has occupied an important place in modern social life and has become a state policy priority. Experts of the World Health Organization believe that the population's health depends primarily on a complete diet and genotypic characteristics, environmental conditions, and social conditions [12]; therefore, research in agriculture alternatives such as green technologies is rising. Hassoun et al. [13] conclude that green technologies are revolutionizing agriculture and food production, so more green and digital solutions are expected to be applied shortly to achieve a healthier food system. Hence, for TF-based studies, it is necessary to have a large amount of satellite data in agriculture, which can help farmers make accurate decisions [14]. Also, it is ideal that the public and private sectors help create database platforms for precision agriculture to improve food quantity and quality.

Currently, the food sector is faced with meeting the consumer needs who take care of their health and seek foods that help preserve it. Moreover, the food industry aims to be sustainable and competitive and provide foods with functional properties while decreasing highly processed foods, as they are considered harmful to human health [15,16]; this is why a recent field of study and market has opened up for the development of functional foods. Among these foods, it is observed that the growth in the production and study fields of functional chocolates has been increasing in recent years. It is known that functional chocolate optimizes the positive aspects in terms of nutritional and bioactive composition, for which the use of processing technologies is the critical factor for producing these innovative foodstuffs [17]. Moreover, efficiency in the production of functional chocolates involves a thorough study of its production chain based on research strategies in comparison to other products of traditional uses [17] to meet the demands of more selective consumers in terms of food quality [16].

Chocolate is a product derived from the processing of cocoa (*Theobroma cacao* L.), consumed and enjoyed worldwide by people of all ages due to its sensory characteristics [18]. However, adding sugar and high-saturated fatty acids (around 60%) to chocolate can harm those who consume it. Likewise, consumers' reduced calories need, dental health care, and obesity reduction change the advantages of chocolate into disadvantages [19,20]. So, the development of functional chocolates as new low-calorie chocolates substituting fat and sugar with alternative components [21], as well as chocolates fortified with bioactive compounds [22] are gaining a lot of research interest in the scientific community. Since there are no studies on functional chocolates' current and future situation, we consider it essential to develop these products TW based on bibliometric studies, which manufacturers and researchers can use. Therefore, we consider it worthwhile to conduct a bibliometric review on functional chocolates, which, as mentioned by Snyder [23], allows us to compile the main findings on technological innovation in the chocolate industry [15,24].

2. The functional food sector

The term "functional foods" dates back to the 60' with the discovery that polyunsaturated fatty acids help to control the blood cholesterol level [25]. Similarly, Gok & Ulu and Granato et al. [26,27] reported that the term "functional foods" was first used in Japan in 1980, mentioning that foods "enriched" in their components provide beneficial physiological effects on human health [28]. However, functional foods have quite a long history; it is known that there are traditional foods associated with specific health benefits. Moreover, interest in developing such foods and beverages has emerged since the second half of the 20th century [17], along with the development of regulatory systems for functional foods, through organizations such as the Federal Food and Drug Administration (USA), Food Safety and Standards Authority (India), Food and Drug Administration (China), European Union (EU), National Health Surveillance Agency (Brazil); among others [29]. Ultimately, these precedents were the foundation of the functional foods growing innovation, with a broad spectrum of bioactive compounds beneficial to health [27,29]; being Europeans, North Americans, and Japanese the leaders of this field of study [16].

Based on the bibliometric tools following Equation 1 search, we can notice that consumers are aware of the diet importance in human health and preferentially choose functional food products [30–32].

TITLE ("functional food") AND (LIMIT-TO (PUBYEAR, 2023) OR LIMIT-TO (PUBYEAR, 2022) OR LIMIT-TO (PUBYEAR, 2021) OR LIMIT-TO (PUBYEAR, 2020) OR LIMIT-TO (PUBYEAR, 2019) OR LIMIT-TO (PUBYEAR, 2018) OR LIMIT-TO (PUBYEAR, 2017) OR LIMIT-TO (PUBYEAR, 2016) OR LIMIT-TO (PUBYEAR, 2015) OR LIMIT-TO (PUBYEAR, 2014)) AND (LIMIT-TO (SUBJAREA, "AGRI")) (Equation 1).

Recently, functional food demand in the global market has increased rapidly due to the increasing number of diseases and technological advancements [33–35]. The functional foods' health benefit derives from bioactive compounds (i.e. fruits), such as phytochemicals (i.e. plant extracts), prebiotics (i.e. vegetables and grains), probiotics (i.e. fermented foods), and amino acids (i.e. fruits and vegetables), that are naturally found in them, formed during processing, extracted from other sources, and added to them [33,35, 36]. Generally, it can be evidenced that fruits, vegetables, legumes, nuts, spices, meats, and vegetable oils are the main sources of functional ingredients that are consumed daily [16]. In addition to identifying and quantifying potential bioactive compounds, it is

food ingredients to produce fortified beverages. As for cocoa, the primary raw material of chocolate, the hydrolysis of cocoa bean protein results in the release of bioactive peptides with potential health properties against hypertension, diabetes, Alzheimer's, obesity, and tumoral problems [49–52]. However, bioaccessibility and bioavailability in vivo studies of these peptides and clinical trials are needed. This knowledge may allow the development of nutraceuticals and food products with specific biological activities as well as pleasing aromas and flavors [53,54].

With the dimensional scaling and words found, the technological map related to functional foods was constructed (Fig. 1) [55,56]; this mapped the studies in functional foods according to study topics. In the first group (red), trends are oriented towards new sources of bioactive compounds (polyphenols and flavonoids) from fruits and plant extracts with antioxidant potential; they also include studies on chemical analysis to demonstrate their bioactivity and nutritional value. The second group includes bioactivity studies carried out on animals.

According to the literature obtained through bibliometrics, Table 1 shows some functional foods in the Spanish market related to their beneficial properties for human health. The most consumed functional foods are those made from cereals and vegetables supplemented with minerals and vitamin D.

2.2. Functional chocolates

Functional chocolates have been developed in scientific research worldwide; efficiency in the production of it involves a thorough study of its production chain based on research strategies in comparison to other products of traditional uses [17] to meet the demands of more selective consumers in terms of food quality [16]. Information related to functional chocolates is available by applying a bibliometric study with Biblioshiny of RStudio from data extracted from Scopus, using the search Equation 2:

TITLE-ABS-KEY (functional AND chocolate) AND (LIMIT-TO (PUBYEAR, 2023) OR LIMIT-TO (PUBYEAR, 2022) OR LIMIT-TO (PUBYEAR, 2021) OR LIMIT-TO (PUBYEAR, 2020) OR LIMIT-TO (PUBYEAR, 2019) OR LIMIT-TO (PUBYEAR, 2018) OR LIMIT-TO (PUBYEAR, 2017) OR LIMIT-TO (PUBYEAR, 2016) OR LIMIT-TO (PUBYEAR, 2015) OR LIMIT-TO (PUBYEAR, 2014)) AND (LIMIT-TO (SUBJAREA, "AGRI")) (Equation 2).

In this regard, El-Hadad et al. [57] included functional chocolates in a cream spread, replacing cocoa butter with palm olein, and measured the number of tocopherols and tocotrienols compared to conventional chocolates. Fayaz et al. [58] studied the effectiveness of pomegranate seed oil oleogel as a partial replacement of the fat phase in chocolate spread; using different techniques, such as polarized light microscopy, synchrotron XRD, mechanical analysis, and oil binding capacity, studied chocolates' physical and mechanical properties. Toker et al. [59] developed functional white chocolate by enriching it with eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA), determining water activity, hardness, yield strength, plastic viscosity, and energy required for complete melting. They concluded that produced white Chocolate with EPA/DHA can carry heat-sensitive bioactive substances.

In the same way, Fakhari et al. [60] indicated that regular consumption of flavanol-rich dark chocolate complemented with pilates (an exercise recommended to diabetic patients for its health benefits) significantly increases the total antioxidant capacity status and fasting blood glucose. The study by Dala-Paula et al. [51] reported that the bioaccessibility of amines and amino acids in 70% bitter chocolate increased after in vitro simulation of oral, gastric, and intestinal digestions. Deus et al. [61] investigated amino acids and bioactive amines (spermidine, tryptamine, agmatine, and phenylethylamines) in nine cocoa clones and their impact on the quality, safety, and functional properties of chocolates. Muhammad et al. [62] studied the potential of cinnamon (*Cinnamomum burmannii*) extracts to enhance the health-promoting properties of white chocolate. They reported that containing cinnamon extract, catechin, epicatechin, procyanidin B2, quercitrin, 3,4-dihydroxy benzaldehyde, protocatechuic acid, and cinnamic acid increased the white Chocolate phenolic content. Kiumarsi [63] substituted sucrose with different levels of hydrophobically-modified inulin as a biopolymeric surfactant in low-calorie chocolates. The study demonstrated that increasing inulin content gives the chocolate an excellent textural and color appearance.

In the same way, Rezende [64] developed sucrose-free chocolate employing a blended design to add fibers as partial substitutes for cocoa butter. Combining different inulin contents and β -glucan concentrate up to 50% of the cocoa butter formulation resulted in products with good acceptance. Martini et al. [65] prepared dark chocolate incorporating Sakura green tea leaves. Another example is the addition of turmeric powder to chocolates, causing the modification of the phenolic profile, resulting in increased phenolic concentration. Belšćak-Cvitanović et al. [66] developed dark chocolates incorporating 3% red raspberry (*Rubus idaeus* L.) leaf extract, improving the content of the total phenolic compounds. Toker et al. [59] report that fortified white chocolates supplied with

Table 1
Summary of functional food groups related to a disease risk reduction in the Spanish market.

Food Group	Disease risk reduction	Number of products
Cookies, oatmeal Bread and similar products	Oat beta-glucan has been shown to lower blood cholesterol. High cholesterol is a risk factor in the development of coronary heart disease.	5
Oat-based cereals		1
Oat grains		2
Vegetable shortening	Plant sterols have been shown to lower blood cholesterol. High cholesterol is a risk factor in the development of coronary heart disease.	28
Vitamins and mineral supplements	Calcium and vitamin D help reduce bone mineral loss in postmenopausal women. Low bone mineral density is a risk factor for osteoporotic bone fractures.	36

eicosapentaenoic and docosahexaenoic acid (EPA and DHA) from microalgae or powder had desired quality, concluding that white chocolate can be used as a carrier of heat-sensitive bioactive substances.

We can notice in Fig. 2 that 248 research articles on functional chocolates are reported, according to the methodology used by Vargas & Castellanos [67]. It can be noted that the word "chocolate" is the one that appears most frequently and is followed by "functional food", "cocoa", "functional foods," and "polyphenols".

Fig. 3 reports trend topics related to functional chocolates, which have increased recently. In 2020 functional chocolate quality properties were investigated, studying texture and the phenomena that govern their behavior [55,56]. Recently, newly available studies related to physicochemical properties and functionality appeared. This property is easy to understand since the quality of chocolate is not only in its flavor and aroma but also in its physical quality, which depends mainly on the characteristics of cocoa butter.

2.3. Patent analysis of functional chocolate patents

The Patentinspiration tool was used with the search term "Functional chocolate," finding 38 patents, of which only seven declared functional foods. These chocolates contain *trans*-resveratrol, trehalose/fruit powder, L-carnitine, dandelion, and calcium/vitamin D. We also found 20 patents for preparing functional chocolates with Ganoderma, maca, turmeric, linolenic acid, and L-arabinose. China and Russia have applied for the registration of functional chocolate patents, with ten and two patents, respectively (Fig. 4) [68]. In the Lens database [69], 79 patents for functional chocolates and their method of preparation were found.

Fig. 5 reports the number of patents published in recent years. Generally, it shows an increasing trend in publishing functional chocolate patents, with the highest number being granted in 2019. However, in 2020 the number of patents granted has dramatically reduced.

Table 2 shows that most of the patented functional chocolates incorporate vegetables as a source of active ingredients (molecules that have bioactive properties); for example, vegetable extracts as a source of polyphenols, flavonoids, and anthocyanins. Other patents include the procedures for functional chocolate making, the ingredients' proportions used, and the quality properties of the final product (rheological properties, texture, crystallization, and melting, among others). Therefore, it is essential to know the properties of the ingredients, manufacturing methods, quality characteristics, and clinical studies of functional chocolate before launching the patent to the market and its subsequent commercialization.

The "Functional Chocolate Production" patent with code US2020022381A1, published on January 22, 2020, consists of a mixture of cocoa bean and plant extracts. This plant extract is rich in polyphenols comprising stilbenoids, catechins, epicatechins, gallic acid, anthocyanins, anthocyanidins, curcumin, flavones, flavanols, flavanones, isoflavones, chalcones, phenolic acids, and lignans. The extract is obtained from the berry group comprising Aronia, chokeberries, rowanberries, blueberries, black currants, gooseberries, cherries, acai, barberry, sea buckthorn, and blackberries. The product is characterized by its antioxidant, anti-inflammatory, anti-hypoxia, vascular activity-enhancing, and other health benefits. These properties were proven through clinical studies in volunteers; the first study was to establish the impact of functional chocolates with Aronia extracts on postprandial glucose levels, concluding that functional chocolate did not affect postprandial glucose; therefore, it was safe. Another study consisted of transresveratrol (t-RSV)

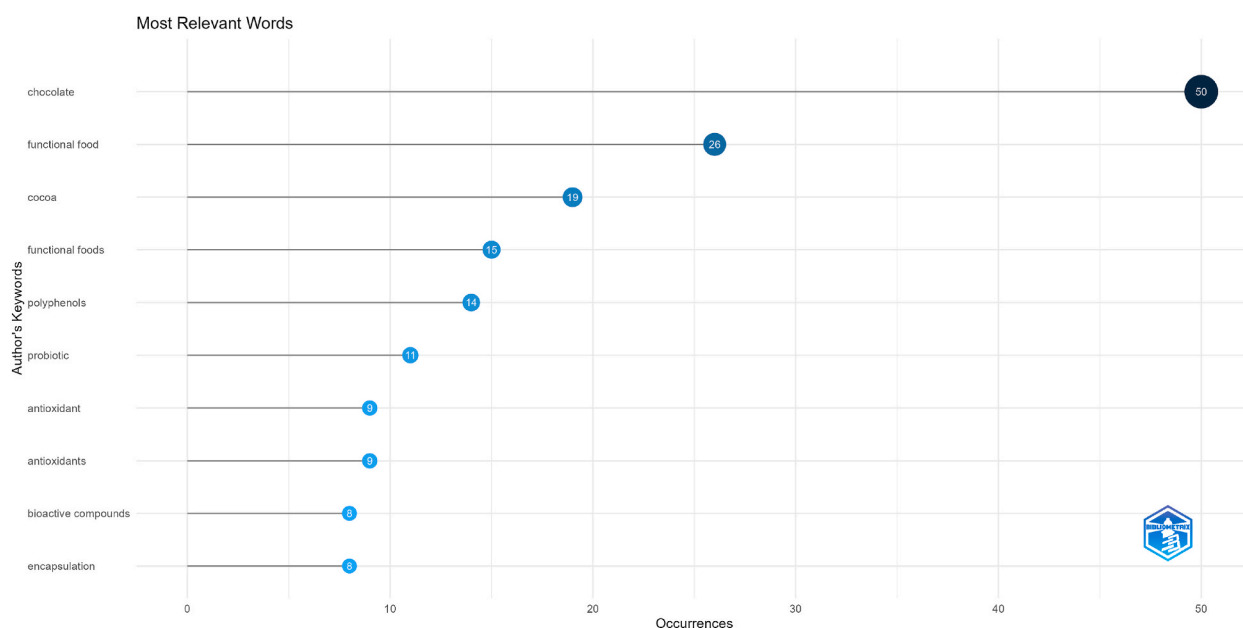


Fig. 2. Relevant words related to "functional chocolate".

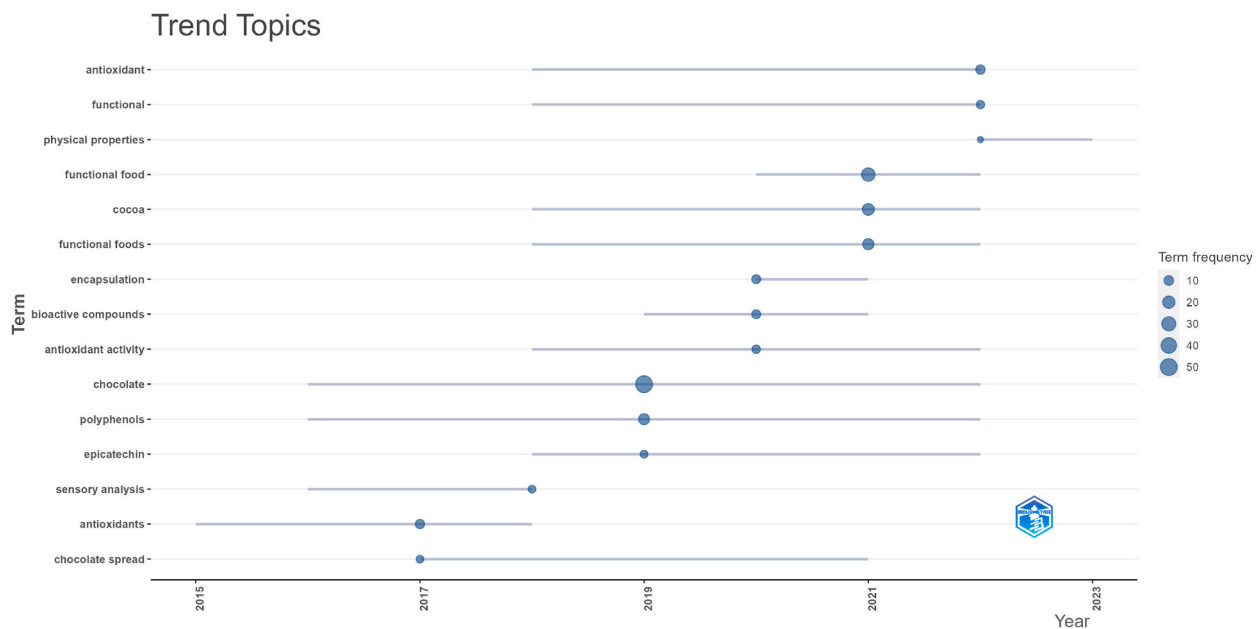


Fig. 3. Trend of the studied topics related to functional chocolates.

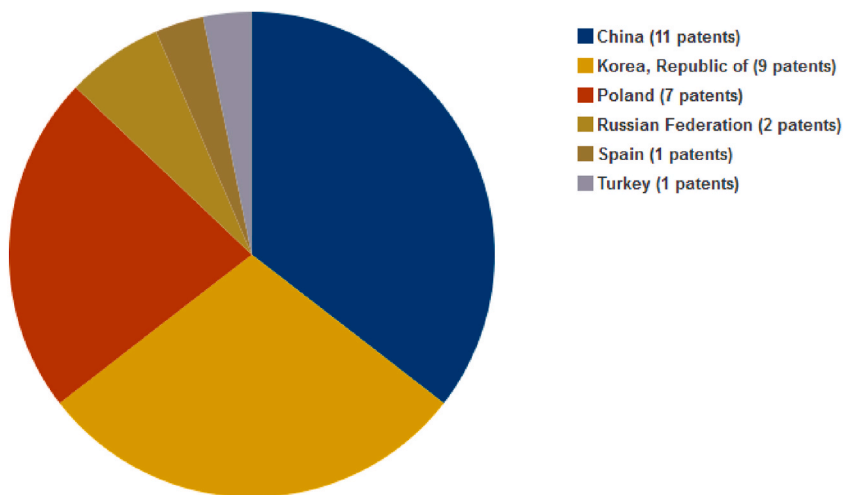


Fig. 4. Countries registering functional chocolate patents and processing methods. The most intense colors show the highest number of existing patents.

pharmacokinetics and epicatechin contained in chocolates, thus, demonstrating an increase in the blood serum t-RSV concentration during the first 4 h of ingestion. Epicatechin concentration was 2.75 times higher after consuming functional chocolate than conventional Chocolate [70]. Another example is ACTICOA, which is a product that retains up to 80% of polyphenols [71] and flavonols [72] in raw cocoa, from which obtained tasty functional chocolate positively impacts cardiovascular health. In yet another aspect, a method of increasing the level of resveratrol, catechins, and other polyphenols in blood serum is provided, comprising the method of administering a consumable product such as milk chocolate to a consumer or patient in need.

2.4. Functional chocolate market

We can observe in Fig. 6, that chocolate is a \$100 billion industry in the United States, involving a range of products that are some of the most popular among consumers. More than 600 million people in the West alone consume these products. Eighty-five percent of these people prefer milk chocolate (i.e., chocolate products with less than 50% cocoa solids). Dark chocolate is healthier because it contains less sugar, is richer in polyphenols with beneficial health properties, interferes with glucose absorption in the intestine,

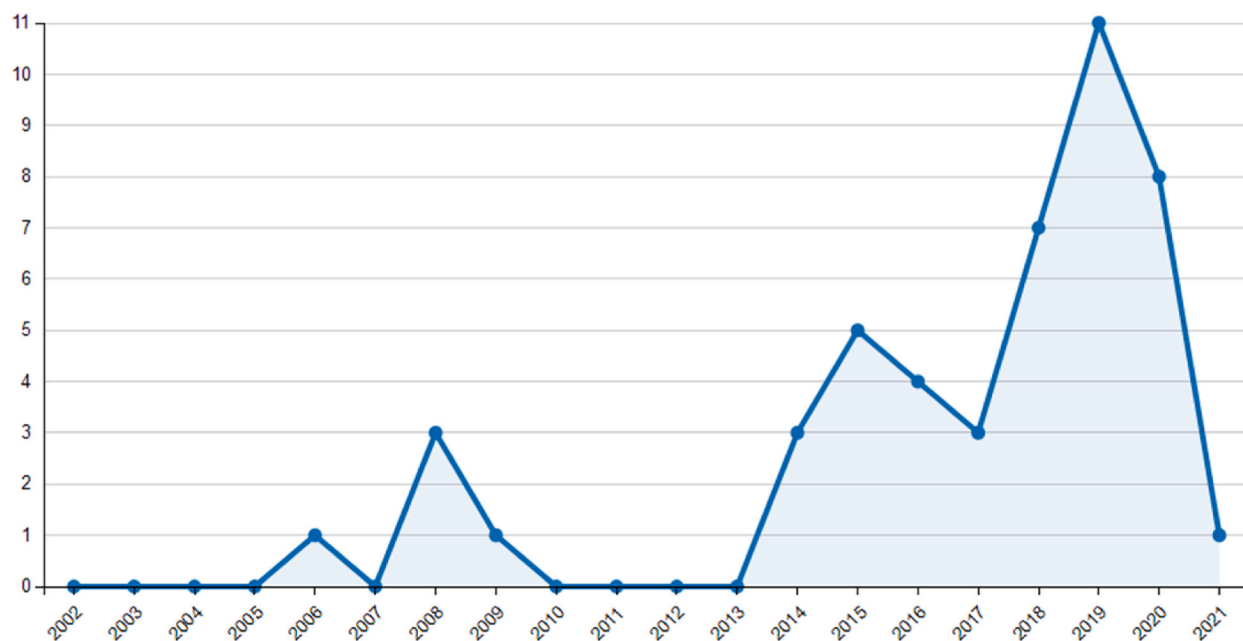


Fig. 5. Evolution of patent publications of functional chocolates.

supports insulin function, and facilitates more efficient glucose utilization. Dark chocolate contains catechins and epicatechins, which benefit the cardiovascular system, mitochondrial metabolism, and epithelial metabolism [68].

Moreover, according to the Observatory of Economic Complexity, Chocolate ranks 129th among the most traded products [73]. In 2018 (Fig. 6A), Germany was the largest exporter of chocolate with a share of \$5.17B, having as its primary buyer the United States (\$2.76B). After Germany, the largest exporters were Belgium (\$3.13B), Italy (\$2.1B), the Netherlands (\$1.93B), and Poland (\$1.74B). We can see in Fig. 6B that the largest importer of chocolate was the United States with 9.47% (\$2.76B), followed by Germany (\$2.36B), France (\$2.31B), the United Kingdom (\$2.28B), and the Netherlands (\$1.41B).

The percentage indicated the participation of each country in the global market in chocolates (A) Exportations and (B) Importations.

Finally, in the South American market, Brazil was the largest exporter of chocolate (\$161.9 M), followed by Argentina (\$112.9 M) and Colombia (\$61 M) (Fig. 7a). Brazil also ranked first in chocolate imports (\$180.3 M), followed by Chile (\$86.4 M), Argentina (\$67.9 M), and Colombia (\$49.9 M) (Fig. 7b). As a cocoa producer, Peru has no significant share in the chocolate market (\$23.5 M in exports and \$43.9 M in imports).

2.5. Undertaking and research projects related to functional foods and chocolates

A search about functional chocolate innovative ventures on the Kickstarter website demonstrated that they are called "Addictive Wellness," which consists of "Raw" chocolate made purely from superfoods and herbs. It is raw, vegan, sugar-free, soy-free, gluten-free, non-GMO, and nut-free. The chocolates taste similar, but each has a specific set of superherbs for a different function (energy, beauty, and tranquility) [74].

Regarding research projects, the National Council for Science, Technology, and Technological Innovation (Concytec) is financing the development of a functional product based on Cocona (*Solanum sessiliflorum*) to lower cholesterol and triglyceride levels in the blood, the leading causes of cardiovascular diseases. This product will allow lowering of cholesterol and triglyceride levels in the blood naturally and without side effects [75]. Moreover, they determined the nutritional composition, the bioactive compounds, the antioxidant activity, and the lipid-lowering effect of five Cocona ecotypes, identifying the best which will serve as raw material for making the functional beverage from Cocona pulp.

3. Conclusion

The worldwide technological development of functional food, concerning chocolates, is at the level of patents. There are unknown functional chocolates sold under that specific name. However, some chocolates serve as "carriers" of bioactive compounds. Nevertheless, they should not be attributed to beneficial properties since they must be evaluated *in vitro*, *in vivo*, and in clinical studies. Launching functional chocolate to the market is possible. However, it would be a long-term process involving previous stages, such as studying the bioactive properties of its ingredients, developing the product at the laboratory level, studying the product's functional properties, and determining quality and acceptance parameters. At an academic-research level, speaking of functional, potentially

Table 2
Patents for functional chocolates are found worldwide.

Item	Patent name	Year	Country	Description
01	Combined functional chocolate and method preparation	2020	China	White Chocolate with Pueraria powder and dark chocolate with blueberry anthocyanin, vitamin C, and lycopene dissipate the effects of alcohol, protect the liver and prevent oxidative damage.
02	Functional Chocolate	2020	China	Chocolate incorporating plant extract rich in polyphenols, wherein said consumable product comprises between 1 and 20% plant extract.
03	Chocolate preparation composition and production method.	2019	Rusia	Chocolate with high organoleptic characteristics, biological value, structural-mechanical, physical-chemical quality, and low glycemic index, incorporating stilbenoids, catechins, epicatechins, gallic acid, anthocyanins, anthocyanidins, curcumin, flavones, flavonoids, flavanones, isoflavones, chalcones, phenolic acids, and lignans.
04	Ganoderma spore powder functional chocolate chip and preparation method	2019	China	Chocolate with a light fragrance of Ganoderma spores is an excellent healthcare food with relatively good social and economic benefits.
05	Preparation system and method for functional chocolate containing anthocyanins from black rice	2019	China	Preparation system and method of functional chocolate containing black rice anthocyanins related to the technical field of chocolate production.
06	Fruit Chocolate	2019	China	Improved health preservation, healthier and delicately fragrant taste. Incorporates fruit powder, trehalose, and likely.
07	Functional chocolate and preparation method.	2019	China	Using a traditional chocolate preparation technology, incorporating resveratrol and chrysanthemum morifolium powder.
08	Functional chocolate and preparation method.	2019	China	Chocolate with added lutein. The product can prevent severe myopia and has remarkable curative effects in recovering multiple eye diseases.
09	Composition for chocolate production	2019	Rusia	Incorporating ginseng allows for obtaining chocolate with a high biological value due to the supercritical ginseng extraction technology.
10	Chocolate is capable of dissipating the effects of alcohol and protecting the liver and its preparation method.	2018	China	Chocolate accelerates ethanol decomposition protecting the liver. It can also be used to relieve headaches caused by alcohol consumption. It includes Radix Pueraria, Fructus schisandrae chinensis extract, and likelies.
11	Functional Chocolate	2018	Polonia	The product is characterized by its containing vegetable extract rich in polyphenols.
12	Chocolate with peach and preparation method	2017	Korea	Functional chocolate with enhanced antioxidant activity by incorporating freeze-dried peach and freeze-dried peach powder.
13	Chocolate with maca and preparation method	2017	China	Chocolate for resisting fatigue, improving immunity, and meeting people's demand for functional chocolate.
14	Chocolate coated with curcumin and method of manufacture	2016	Korea	Chocolate products are coated with curcumin, thus increasing the absorption rate of curcumin in the body, where curcumin is a functional substance.
15	Chocolate and confectionery containing garcinia cambogia extract and manufacturing method	2017	Korea	Due to physiological activities and effects, functional chocolates are added with Garcinia cambogia powder extract to improve health.
16	Functional chocolate that helps to lose weight	2016	Turquía	The product has various combinations of L-carnitine, vitamins, grape seed or grape seed extract, green tea or green tea extract, ginger root, and cinnamon.
17	Modified cocoa butter, functional chocolate, and preparation method	2015	China	The modified cocoa butter contains polyunsaturated fatty acids DHA and EPA. The functional chocolate has a smooth surface, delicate flavor, no apparent fishy odor, moderate cocoa flavor, and good storage performance.
18	Modified cocoa butter and functional chocolate containing linolenic acid and preparation method	2015	China	Functional chocolate containing more linolenic acid, with better nutritional and health functions.
19	Preparation method of functional chocolate refined with L-arabinose	2015	China	Functional chocolate inhibits sucrose absorption, insulin secretion, and obesity incidence, preventing the occurrence of high blood sugar levels, and is nutritious.
20	Preparation method of functional chocolate using okra, mushrooms, and algae vegetable components.	2015	China	The invention relates to preparing functional chocolate by using a vegetable okra-fungus-algae composition.
21	Functional chocolate and preparation method	2016	China	Chocolate that incorporates fruit powder, dietary fiber, and DHA. The product complements nutrients for health care with better stability, shelf life, and high-temperature tolerance during transportation.
22	Chocolate with dandelion and deodeok	2014	Korea	Functional chocolate using dandelion and Codonopsis lanceolata are well known for its functional health characteristics.
23	A nutritious and functional chocolate food	2009	México	Nutritional and functional chocolate including a cocoa-based composition with calcium, vitamin D, and a trace element dispensed in a marshmallow.
24	A novel method to prepare a functional chocolate	2008	Korea	The herbal chocolate production method eliminates medicinal herbs' characteristic flavor and bitter taste while providing a pharmacologically active component.
25	Functional composition of chocolate and preparation method	2008	Korea	It provides a functional chocolate composition and preparation method to improve its nutritional value and taste. It contains medicinal herbs: Polygala tenuifolia Willdenow, ginseng, Poria cocos, Zizyphus jujuba Miller seeds, vitamins, and calcium.

functional, or enriched bioactive compounds in chocolate is possible since the research development does not necessarily involve launching the product on the market, i.e., these are not done for commercial purposes. Despite being a cocoa producer, the raw material for chocolate in Peru has no patent applications for functional chocolate, and scientific research related to this product needs to be improved.

There are still different fields of study to be explored in producing functional chocolates; currently, technologies are needed to take

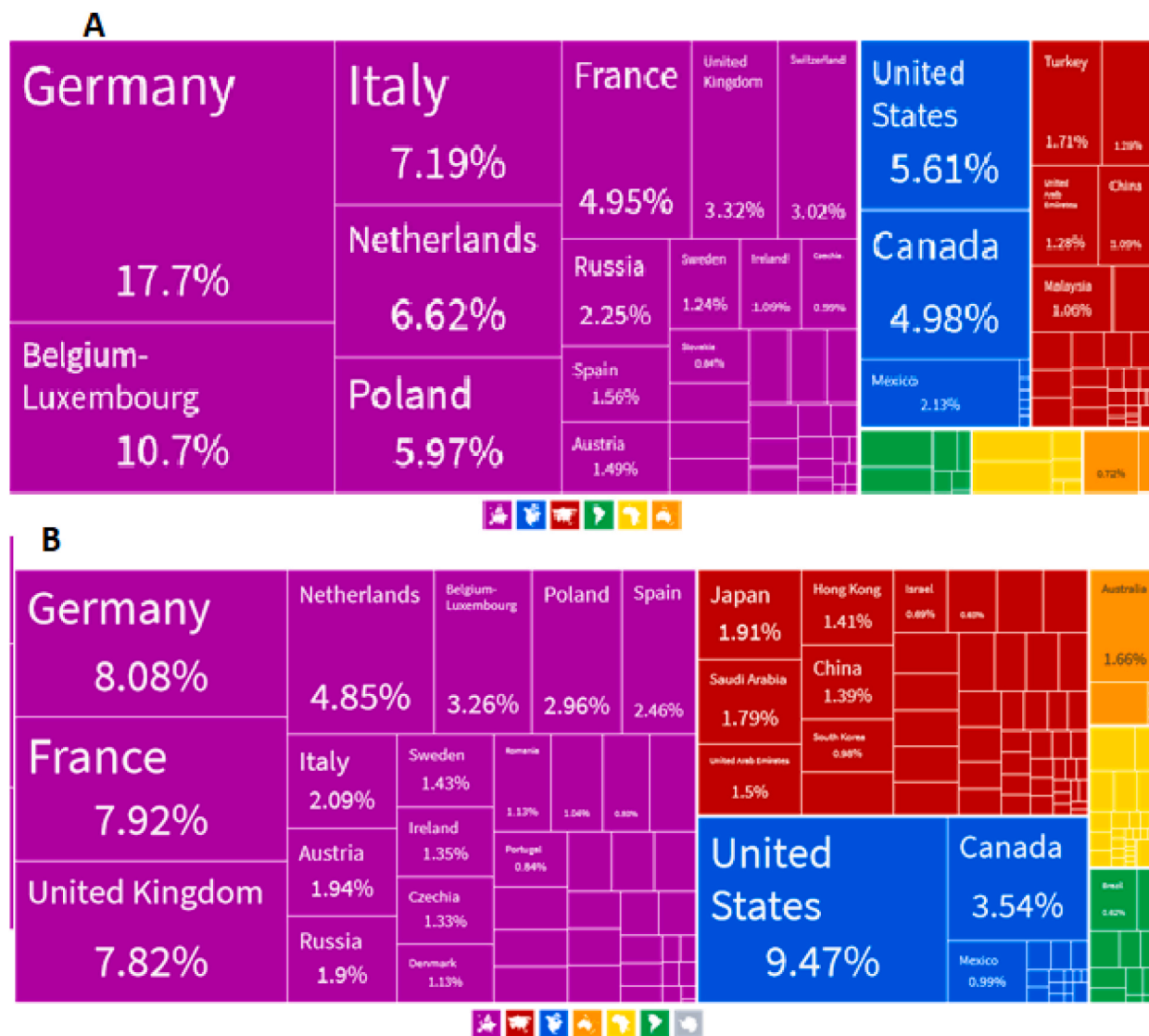


Fig. 6. Word TreeMap about European chocolate market.

advantage of potentially functional ingredients from plants and fruits traditionally used for medicinal purposes. Moreover, the active principles of these ingredients can be harnessed for their antioxidant, soothing, healing, and other properties. Likewise, to take advantage of this immense source of natural ingredients to be incorporated into functional chocolates, there is still a vast field to explore, such as encapsulation that protects the concentration and preservation of their active ingredients and properties or methods of adding native ingredients and formulas for preparation.

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Author contribution statement

All authors listed have significantly contributed to the development and the writing of this article.



Fig. 7. South American chocolate exports and imports.

Data availability statement

Data included in article/supplementary material/referenced in article.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

References

- [1] A. Perez, R. Basagoiti, R.A. Cortez, F. Larrinaga, E. Barrasa, A. Urrutia, A case study on the use of machine learning techniques for supporting technology watch, *Data Knowl. Eng.* 117 (2018) 239–251, <https://doi.org/10.1016/j.datak.2018.08.001>.
- [2] D.S.M.P. Filho, D.D.J. de Macedo, M.L. Dutra, Technological surveillance in Big data environments by using a MapReduce-based method, *Mobile Network. Appl.* (2022), <https://doi.org/10.1007/s11036-022-01962-2>.
- [3] R. Rentería, D.M. Vásquez, WORKSHOP: technological surveillance and strategic intelligence for innovation and competitiveness in organizations, in: 2022 IEEE World Engineering Education Conference, EDUNINE), 2022, pp. 1–3, <https://doi.org/10.1109/EDUNINES3672.2022.9782333>.
- [4] D.S.M.P. Filho, D.D.J. de Macedo, A model for automated technological surveillance of web portals and social networks, *J. Intell. Inf. Syst.* 56 (2021) 561–579, <https://doi.org/10.1007/s10844-021-00641-0>.
- [5] M.I. Ramírez, D. Escobar, B. Arango, Vigilancia tecnológica e Inteligencia competitiva, *Revista Electrónica Gestión de Las Personas y Tecnología*, vol. 5, 2012. <https://www.redalyc.org/pdf/4778/477847114018.pdf>. (Accessed 10 June 2023).
- [6] V. Balza-Franco, Formulación y diseño de un modelo de vigilancia tecnológica curricular en programas de ingeniería en Colombia, *Rev. Educ. Super.* 45 (2016) 55–77, <https://doi.org/10.1016/j.resu.2016.04.008>.
- [7] D.L. Pineda Ospina, Bibliometric Analysis for the Identification of Factors of Innovation in the Food Industry, *AD-Minister*, vols. 95–126, 2015, <https://doi.org/10.17230/ad-minister.27.5>.
- [8] C. Hernández, Vigilancia Tecnológica de Big Data en el Sector de Seguros, in: Asociación Latino-Iberoamericana de Gestión Tecnológica (ALTEC), 2019. Colombia, <https://www.altecasociacion.org/>. (Accessed 25 November 2020).

- [9] K. Lebelo, M. Masinde, N. Malebo, M.J. Mochane, The surveillance and prediction of food contamination using intelligent systems: a bibliometric analysis, *Br. Food J.* 124 (2021) 1149–1169, <https://doi.org/10.1108/BFJ-04-2021-0366>.
- [10] F. Kreuchau, V. Korzinov, A patent search strategy based on machine learning for the emerging field of service robotics, *Scientometrics* 111 (2017) 743–772, <https://doi.org/10.1007/s11192-017-2268-3>.
- [11] H. Chen, W. Jiang, Y. Yang, Y. Yang, X. Man, State of the art on food waste research: a bibliometrics study from 1997 to 2014, *J. Clean. Prod.* 140 (2017) 840–846, <https://doi.org/10.1016/j.jclepro.2015.11.085>.
- [12] I.B. Kirina, F.G. Belosokhov, L.V. Titova, I.A. Suraykina, V.F. Pulpitov, Biochemical assessment of berry crops as a source of production of functional food products, *IOP Conf. Ser. Earth Environ. Sci.* 548 (2020), 082068, <https://doi.org/10.1088/1755-1315/548/8/082068>.
- [13] A. Hassoun, M.A. Prieto, M. Carpena, Y. Bouzemrak, H.J.P. Marvin, N. Pallarés, F.J. Garba, S. Punia Bangar, V. Chaudhary, S. Ibrahim, G. Bono, Exploring the role of green and Industry 4.0 technologies in achieving sustainable development goals in food sectors, *Food Res. Int.* 162 (2022), 112068, <https://doi.org/10.1016/j.foodres.2022.112068>.
- [14] V. Šafář, K. Charvát, T. Mildorf, P. Crehan, D. Kolitzus, T. Orlickas, M. Rimgaila, A. Kučinskas, S. Rybokiėnė, Š. Horáková, H. Kubíčková, The role of remote sensing in agriculture and future vision, *AOL* 1 (2022) 107–124, <https://doi.org/10.7160/aol.2022.140109>.
- [15] M. Castillo-Vergara, I. Quispe-Puentes, J. Poblete, Technological innovation in the food industry: a bibliometric analysis, *Eng. Econ.* 32 (2021) 197–209, <https://doi.org/10.5755/joi.ee.32.3.26000>.
- [16] A.D. Tripathi, R. Mishra, K.K. Maurya, R.B. Singh, D.W. Wilson, Chapter 1 - estimates for world population and global food availability for global health, in: R. B. Singh, R.R. Watson, T. Takahashi (Eds.), *The Role of Functional Food Security in Global Health*, Academic Press, 2019, pp. 3–24, <https://doi.org/10.1016/B978-0-12-813148-0.00001-3>.
- [17] J.A. Weststrate, G. van Poppel, P.M. Verschuren, Functional foods, trends and future, *Br. J. Nutr.* 88 (2002), <https://doi.org/10.1079/BJN2002688>, S233–S235.
- [18] G.S. Silva, B.M. Dala-Paula, E.S. Bispo, M.B.A. Gloria, Bioaccessibility of bioactive amines in dark chocolates made with different proportions of under-fermented and fermented cocoa beans, *Food Chem.* 404 (2023), 134725, <https://doi.org/10.1016/j.foodchem.2022.134725>.
- [19] N. Konar, O.S. Tokar, S. Oba, O. Sagdic, Improving functionality of chocolate: a review on probiotic, prebiotic, and/or synbiotic characteristics, *Trends Food Sci. Technol.* 49 (2016) 35–44, <https://doi.org/10.1016/j.tifs.2016.01.002>.
- [20] S. You, Q. Huang, X. Lu, Development of fat-reduced 3D printed chocolate by substituting cocoa butter with water-in-oil emulsions, *Food Hydrocolloids* 135 (2023), 108114, <https://doi.org/10.1016/j.foodhyd.2022.108114>.
- [21] Y. Chen, W. Wang, W. Zhang, C.-P. Tan, D. Lan, Y. Wang, Characteristics and feasibility of olive oil-based diacylglycerol plastic fat for use in compound chocolate, *Food Chem.* 391 (2022), 133254, <https://doi.org/10.1016/j.foodchem.2022.133254>.
- [22] S. Samanta, T. Sarkar, R. Chakraborty, M. Rebezov, M.A. Shariati, M. Thiruvengadam, K.R.R. Rengasamy, Dark chocolate: an overview of its biological activity, processing, and fortification approaches, *Curr. Res. Food Sci.* 5 (2022) 1916–1943, <https://doi.org/10.1016/j.crf.2022.10.017>.
- [23] H. Snyder, Literature review as a research methodology: an overview and guidelines, *J. Bus. Res.* 104 (2019) 333–339, <https://doi.org/10.1016/j.jbusres.2019.07.039>.
- [24] J.L. Alexandre-Tudo, L. Castello-Cogollos, J.L. Alexandre, R. Alexandre-Benavent, Chemometrics in food science and technology: a bibliometric study, *Chemometr. Intell. Lab. Syst. Syst.* 222 (2022), 104514, <https://doi.org/10.1016/j.chemolab.2022.104514>.
- [25] A.W.K. Yeung, A. Mocan, A.G. Atanasov, Let food be thy medicine and medicine be thy food: a bibliometric analysis of the most cited papers focusing on nutraceuticals and functional foods, *Food Chem.* 269 (2018) 455–465, <https://doi.org/10.1016/j.foodchem.2018.06.139>.
- [26] I. Gok, E.K. Ulu, Functional foods in Turkey: marketing, consumer awareness and regulatory aspects, *Nutr. Food Sci.* 49 (2018) 668–686, <https://doi.org/10.1108/NFS-07-2018-0198>.
- [27] D. Granato, F.J. Barba, D. Bursać Kovačević, J.M. Lorenzo, A.G. Cruz, P. Putnik, Functional foods: product development, technological trends, efficacy testing, and safety, *Annu. Rev. Food Sci. Technol.* 11 (2020) 93–118, <https://doi.org/10.1146/annurev-food-032519-051708>.
- [28] M. Konstantinidi, A.E. Koutelidakis, Functional foods and bioactive compounds: a review of its possible role on weight management and obesity's metabolic consequences, *Medicines* 6 (2019) 94, <https://doi.org/10.3390/medicines6030094>.
- [29] B.H. Nataraj, S.A. Ali, P.V. Behare, H. Yadav, Postbiotics-parabiotics: the new horizons in microbial biotechnology and functional foods, *Microb. Cell Factories* 19 (2020) 168, <https://doi.org/10.1186/s12934-020-01426-w>.
- [30] L. Domínguez Díaz, V. Fernández-Ruiz, M. Cámara, An international regulatory review of food health-related claims in functional food products labeling, *J. Funct. Foods* 68 (2020), 103896, <https://doi.org/10.1016/j.jff.2020.103896>.
- [31] C.G. Fernandes, S.K. Sonawane, S.S. Arya, Optimization and modeling of novel multigrain beverage: effect of food additives on physicochemical and functional properties, *J. Food Process. Preserv.* 43 (2019), e14151, <https://doi.org/10.1111/jfpp.14151>.
- [32] M. Vignando, M. Aiello, A. Rinaldi, T. Cattaruzza, G. Mazzon, P. Manganotti, R. Eleopra, R.I. Rumiati, Food knowledge depends upon the integrity of both sensory and functional properties: a VBM, TBSS and DTI tractography study, *Sci. Rep.* 9 (2019) 7439, <https://doi.org/10.1038/s41598-019-43919-8>.
- [33] R. Mishra, A.D. Tripathi, R.B. Singh, R.S. Tomar, D.W. Wilson, M.M.A. Smail, Chapter 2 - estimates of functional food and nutraceutical availability in the world, with reference to food peroxidation and food safety, in: R.B. Singh, S. Watanabe, A.A. Isaza (Eds.), *Functional Foods and Nutraceuticals in Metabolic and Non-communicable Diseases*, Academic Press, 2022, pp. 23–42, <https://doi.org/10.1016/B978-0-12-819815-5.00025-2>.
- [34] W. Sun, M.H. Shahrabajian, Q. Cheng, Chapter 21 - functional food and organic farming for sustainable development with a vision for sustainable food and farming, in: R.B. Singh, S. Watanabe, A.A. Isaza (Eds.), *Functional Foods and Nutraceuticals in Metabolic and Non-communicable Diseases*, Academic Press, 2022, pp. 317–323, <https://doi.org/10.1016/B978-0-12-819815-5.00033-1>.
- [35] S.A. Tadesse, S.A. Emire, Production and processing of antioxidant bioactive peptides: a driving force for the functional food market, *Heliyon* 6 (2020), e04765, <https://doi.org/10.1016/j.heliyon.2020.e04765>.
- [36] M. Butnariu, I. Sarac, Functional food, *IJN* 3 (2019) 7–16, <https://doi.org/10.14302/issn.2379-7835.ijn-19-2615>.
- [37] S. Jayarathne, I. Koboziev, O.-H. Park, W. Oldewage-Theron, C.-L. Shen, N. Moustaid-Moussa, Anti-inflammatory and anti-obesity properties of food bioactive components: effects on adipose tissue, *Prev Nutr Food Sci* 22 (2017) 251–262, <https://doi.org/10.3746/pnf.2017.22.4.251>.
- [38] R.-H. Ma, Z.-J. Ni, Y.-Y. Zhu, K. Thakur, F. Zhang, Y.-Y. Zhang, F. Hu, J.-G. Zhang, Z.-J. Wei, A recent update on the multifaceted health benefits associated with ginger and its bioactive components, *Food Funct.* 12 (2021) 519–542, <https://doi.org/10.1039/D0FO02834G>.
- [39] G. Sandner, Functional foods - dietary or herbal products on obesity: application of selected bioactive compounds to target lipid metabolism, *Curr. Opin. Food Sci.* (2020) 12.
- [40] I. Bibik, S. Doronin, S. Dotsenko, Substantiation of technological approaches to the creation of functional products based on milk and carrot compositions, *E3S Web Conf.* 203 (2020), 04007, <https://doi.org/10.1051/e3sconf/202020304007>.
- [41] F. Valerio, A.R. Bavaro, M. Di Biase, S.L. Lonigro, A.F. Logrieco, P. Lavermicocca, Effect of amaranth and quinoa flours on exopolysaccharide production and protein profile of liquid sourdough fermented by *Weissella cibaria* and *Lactobacillus plantarum*, *Front. Microbiol.* (2020) 11, <https://www.frontiersin.org/articles/10.3389/fmicb.2020.00967>. (Accessed 10 June 2023).
- [42] X. Gong, X. Li, Y. Xia, J. Xu, Q. Li, C. Zhang, M. Li, Effects of phytochemicals from plant-based functional foods on hyperlipidemia and their underpinning mechanisms, *Trends Food Sci. Technol.* 103 (2020) 304–320, <https://doi.org/10.1016/j.tifs.2020.07.026>.
- [43] A. Kapinova, P. Stefanicka, P. Kubatka, P. Zubor, S. Uramova, M. Kello, J. Mojzís, D. Blahutova, T. Qaradakh, A. Zulli, M. Caprnda, J. Danko, Z. Lasabova, D. Busselberg, P. Kruzliak, Are plant-based functional foods better choice against cancer than single phytochemicals? A critical review of current breast cancer research, *Biomed. Pharmacother.* 96 (2017) 1465–1477, <https://doi.org/10.1016/j.biopha.2017.11.134>.
- [44] A. Kumar, K.A. Mosa, L. Ji, U. Kage, D. Dhokane, S. Karre, D. Madalageri, N. Pathania, Metabolomics-assisted biotechnological interventions for developing plant-based functional foods and nutraceuticals, *Crit. Rev. Food Sci. Nutr.* 58 (2018) 1791–1807, <https://doi.org/10.1080/10408398.2017.1285752>.
- [45] H.M. Bayram, S. Arda Ozturkcan, Bioactive components and biological properties of cornelian cherry (*Cornus mas* L.): a comprehensive review, *J. Funct. Foods* 75 (2020), 104252, <https://doi.org/10.1016/j.jff.2020.104252>.

- [46] T. Lafarga, J.M. Fernández-Sevilla, C. González-López, F.G. Acién-Fernández, Spirulina for the food and functional food industries, *Food Res. Int.* 137 (2020), 109356, <https://doi.org/10.1016/j.foodres.2020.109356>.
- [47] J. Wang, X. Zhang, A.B. Omarini, B. Li, Virtual screening for functional foods against the main protease of SARS-CoV-2, *J. Food Biochem.* 44 (2020), <https://doi.org/10.1111/jfbc.13481>.
- [48] S.P. Samaei, M. Ghorbani, D. Tagliazucchi, S. Martini, R. Gotti, T. Themelis, F. Tesini, A. Gianotti, T. Gallina Toschi, E. Babini, Functional, nutritional, antioxidant, sensory properties and comparative peptidomic profile of faba bean (*Vicia faba*, L.) seed protein hydrolysates and fortified apple juice, *Food Chem.* 330 (2020), 127120, <https://doi.org/10.1016/j.foodchem.2020.127120>.
- [49] O.-W. Achaw, E. Danso-Boateng, Cocoa processing and chocolate manufacture, in: O.-W. Achaw, E. Danso-Boateng (Eds.), *Chemical and Process Industries: with Examples of Industries in Ghana*, Springer International Publishing, Cham, 2021, pp. 267–292, https://doi.org/10.1007/978-3-030-79139-1_10.
- [50] S.C.G.N. Braga, L.F. Oliveira, J.C. Hashimoto, M.R. Gama, P. Efraim, R.J. Poppi, F. Augusto, Study of volatile profile in cocoa nibs, cocoa liquor and chocolate on production process using GC × GC-QMS, *Microchem. J.* 141 (2018) 353–361, <https://doi.org/10.1016/j.microc.2018.05.042>.
- [51] B.M. Dala-Paula, V.L. Deus, O.L. Tavano, M.B.A. Gloria, In vitro bioaccessibility of amino acids and bioactive amines in 70% cocoa dark chocolate: what you eat and what you get, *Food Chem.* (2020), 128397, <https://doi.org/10.1016/j.foodchem.2020.128397>.
- [52] V.L. Deus, E.S. Bispo, A.S. Franca, M.B.A. Gloria, Understanding amino acids and bioactive amines changes during on-farm cocoa fermentation, *J. Food Compos. Anal.* 97 (2021), 103776, <https://doi.org/10.1016/j.jfca.2020.103776>.
- [53] L.A. Domínguez-Pérez, L.M. Beltrán-Barriontos, A.F. González-Córdova, A. Hernández-Mendoza, B. Vallejo-Cordoba, Artisanal cocoa bean fermentation: from cocoa bean proteins to bioactive peptides with potential health benefits, *J. Funct. Foods* 73 (2020), 104134, <https://doi.org/10.1016/j.jff.2020.104134>.
- [54] P. Gutiérrez-Macías, V.A. Mirón-Mérida, C.O. Rodríguez-Nava, B.E. Barragán-Huerta, Chapter 13 - cocoa: beyond chocolate, a promising material for potential value-added products, in: R. Bhat (Ed.), *Valorization of Agri-Food Wastes and By-Products*, Academic Press, 2021, pp. 267–288, <https://doi.org/10.1016/B978-0-12-824044-1.00038-6>.
- [55] N.J. van Eck, L. Waltman, *VOSviewer Manual*, Universiteit, Leiden, 2023.
- [56] N.N. Zakaria, P. Convey, C. Gomez-Fuentes, A. Zulkharnain, S. Sabri, N.A. Shaharuddin, S.A. Ahmad, Oil bioremediation in the marine environment of Antarctica: a review and bibliometric keyword cluster analysis, *Microorganisms* 9 (2021) 419, <https://doi.org/10.3390/microorganisms9020419>.
- [57] N.N.M. El-Hadad, M.M. Youssef, M.H. Abd El-Aal, H.H. Abou-Gharbia, Utilisation of red palm olein in formulating functional chocolate spread, *Food Chem.* 124 (2011) 285–290, <https://doi.org/10.1016/j.foodchem.2010.06.034>.
- [58] G. Fayaz, S.A.H. Goli, M. Kadivar, F. Valoppi, L. Barba, S. Calligaris, M.C. Nicoli, Potential application of pomegranate seed oil oleogels based on monoglycerides, beeswax and propolis wax as partial substitutes of palm oil in functional chocolate spread, *LWT* 86 (2017) 523–529, <https://doi.org/10.1016/j.lwt.2017.08.036>.
- [59] O.S. Toker, N. Konar, H.R. Pirouzian, S. Oba, D.G. Polat, İ. Palabiyik, E.S. Poyrazoglu, O. Sagdic, Developing functional white chocolate by incorporating different forms of EPA and DHA - effects on product quality, *LWT - Food Sci. Technol. (Lebensmittel-Wissenschaft -Technol.)* 87 (2018) 177–185, <https://doi.org/10.1016/j.lwt.2017.08.087>.
- [60] M. Fakhari, M. Fakhari, E. BamBaeichi, The effects of pilates and flavanol-rich dark chocolate consumption on the total antioxidant capacity, glycemic control and BMI in diabetic females with neuropathy complications, *J. Bodyw. Mov. Ther.* (2020), <https://doi.org/10.1016/j.jbmt.2020.11.020>. S1360859220302357.
- [61] V.L. Deus, E.S. Bispo, A.S. Franca, M.B.A. Gloria, Influence of cocoa clones on the quality and functional properties of chocolate – nitrogenous compounds, *LWT* 134 (2020), 110202, <https://doi.org/10.1016/j.lwt.2020.110202>.
- [62] M. Muhammad, B. Yan, G. Yao, K. Chao, C. Zhu, Q. Huang, Surface-enhanced Raman spectroscopy for trace detection of tetracycline and dicyandiamide in milk using transparent substrate of Ag nanoparticle arrays, *ACS Appl. Nano Mater.* 3 (2020) 7066–7075, <https://doi.org/10.1021/acsnm.0c01389>.
- [63] M. Kiumarsi, Comparative study of instrumental properties and sensory profiling of low-calorie chocolate containing hydrophobically modified inulin. Part 1: rheological, thermal, structural and external preference mapping, *Food Hydrocolloids* (2020) 13.
- [64] N.V. Rezende, Mixture design applied for the partial replacement of fat with fibre in sucrose-free chocolates, *Food Sci. Technol.* (2015) 7.
- [65] S. Martini, A. Conte, D. Tagliazucchi, Comprehensive evaluation of phenolic profile in dark chocolate and dark chocolate enriched with Sakura green tea leaves or turmeric powder, *Food Res. Int.* 112 (2018) 1–16, <https://doi.org/10.1016/j.foodres.2018.06.020>.
- [66] A. Belščak-Cvitanović, D. Komes, M. Benković, S. Karlović, I. Hečimović, D. Ježek, I. Bauman, Innovative formulations of chocolates enriched with plant polyphenols from *Rubus idaeus* L. leaves and characterization of their physical, bioactive and sensory properties, *Food Res. Int.* 48 (2012) 820–830, <https://doi.org/10.1016/j.foodres.2012.06.023>.
- [67] F. Vargas, O. Castellanos, *Vigilancia como herramienta de innovación y desarrollo tecnológico. Caso de aplicación: sector de empaques plásticos flexibles*, *Revista Ingeniería e Investigación.* 25 (2005) 32–41.
- [68] Visualize PatentInspiration, Code) - PatentInspiration, 2020. <https://app.patentinspiration.com/#report/7be86BFAb680/analysis/29195eC5894D/patents/6117>. (Accessed 13 October 2020).
- [69] Lens.org, Results the Lens - Free & Open Patent and Scholarly Search, the Lens - Free & Open Patent and Scholarly Search, 2020. <https://www.lens.org/lens>. (Accessed 1 December 2020).
- [70] PatentInspiration, Filter (44 Patents) - PatentInspiration, 2020. <https://app.patentinspiration.com/#report/401614D43154/filter/patents/US2020022381A1/description>. (Accessed 2 December 2020).
- [71] F. Visioli, H. Bernaert, R. Corti, C. Ferri, S. Heptinstall, E. Molinari, A. Poli, M. Serafini, H.J. Smit, J.A. Vinson, F. Violi, R. Paoletti, Chocolate, lifestyle, and health, *Crit. Rev. Food Sci. Nutr.* 49 (2009) 299–312, <https://doi.org/10.1080/10408390802066805>.
- [72] M.J. Tallon, Authorised EU health claim for cocoa flavanols, in: *Foods, Nutrients and Food Ingredients with Authorised EU Health Claims*, vol. 2, Elsevier, 2015, pp. 75–93, <https://doi.org/10.1016/B978-1-78242-382-9.00004-9>.
- [73] OEC, Chocolate (HS: 1806) product trade, exporters and importers. <https://oec.world/en/profile/hs92/chocolate>, 2020. (Accessed 12 November 2020).
- [74] Kickstarter, Raw Gourmet Sugar-free Superfood Chocolate with Superherbs, Kickstarter, 2020. <https://www.kickstarter.com/projects/1200575566/raw-gourmet-sugar-free-superfood-chocolate-with-su>. (Accessed 2 December 2020).
- [75] Concytec, A base del fruto de la cocona se busca prevenir enfermedades cardiovasculares y diabetes, 2020. <https://portal.concytec.gob.pe/index.php/noticias/2177-a-base-del-fruto-de-la-cocona-se-busca-prevenir-enfermedades-cardiovasculares-y-diabetes>. (Accessed 7 December 2020).