



## Research Article

### An Investigation in the Key Ingredients in Health and Functional Foods

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#### Abstract

Functional foods are the foods that can be consumed as the part of a normal diet which offers proven physiological benefits and has ability to reduce the risks of certain chronic diseases. This research was conducted to investigate significant ingredients used within health and functional foods currently on the market, and the potential for the use and expansion of new ingredients into health and functional foods. A survey was conducted on 128 individuals in order to determine their knowledge, perception and use with regards to functional foods. The study focused on functional food ingredients currently used within the Irish market, and new functional food ingredients that have potential use. These new functional food ingredients are used in numerous countries worldwide and display a variety of impactful health benefits. The results of the study indicated that Irish consumers have very limited knowledge of ingredients applied in functional food products. Furthermore, consumers have little knowl-

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edge of their exact health benefits; however, they still consumed it, as they perceive it as being “healthy”. The results displayed that consumers would be willing to consume a variety of suggested new ingredients for the incorporation into functional foods. The study concluded that there is potential for the expansion and growth of new ingredients into functional foods within the Irish market.

**Keywords:** Consumer perception; Functional foods; Health benefits; Ingredients

#### Introduction

Functional foods are nutriment consumed to cover the nutritional needs that cannot be met by a normal diet alone [1]. A functional food is defined as “a food containing significant levels of biologically active components that provide specific health benefits beyond the traditional nutrients they contain” [2]. Functional food stand as a new category of remarkably promising foods and are rich in minerals, vitamins, fatty acids, dietary fibre, or foods with added biologically active substances such as phytochemicals, marine bioactive compounds, antioxidants, or prebiotics and probiotics [3,4]. These functional food components play huge roles in the prevention of many diseases and promotion of good health that cause foods to be deemed functional foods. Several health benefits have been reported to be associated with the consumption of functional foods such as glycemic management to the prevention of age-related muscle loss [5], boost energy levels and immune systems, and promote a healthy gut [6], improvement of heart health, reduction of osteoporosis and menopausal symptoms, reduction of cancer risk and anti-obese effects [7].

These health benefit claims render functional foods quite appealing, and subsequently, there has been increased demand for these products. The current most common compounds used as key ingredients in functional foods are omega-3 polyunsaturated fatty acids, vitamins, minerals and probiotics [8]. According to a recent report, there has been a significant growth and an increase in the demand for functional foods; the functional food market produced a global revenue of approximately 299.32 billion US dollars in 2017 and has been projected to reach 441.56 billion US dollars by 2022 [9]. This correlates with the increase in the cost of healthcare, life expectancy, and the desire for an improved quality of life for the elderly [10].

A massive contributing factor in the demand for health-enhancing food products, the growth of consumer awareness and knowledge of health, has been incredibly influenced by media platforms. People are more aware of the foods they are consuming. They have more knowledge of the roles of food in the diet and how they impact people’s health. Within the media, there is a continuous stream of information, advertisements, and broadcast studies displaying healthy lifestyles and the correlation between an individual’s food choices, and its physiological effects [11]. As the demand for functional food products increases, consequently there is a search for new sources of key ingredients. There is a wide range of sources that new and current functional food ingredients are being derived from such as marine, fruit, vegetable, plant, grain and dairy [12].

There has always been a curiosity present in the relationship between a person's health and the foods that they consume. Consumption of foods has a strong correlation to the positive or negative attitudes consumers possess about it. This is affected by advertising, labelling and general consumer awareness of foods and their health benefits. Effective labelling is crucial as it encourages the purchasing and consumption of such products. This is especially prevalent in functional foods with added ingredients that may not naturally occur within the functional food product e.g., omega-3 polyunsaturated fatty acids in bread. Numerous studies were carried out to evaluate purchasing behaviour of functional foods. Oliveira et al. [13], in their study observed that labels largely influence consumers buying decisions, and label design influenced the attentional capture of specific pieces of information on labels. Consumers were found to experience pleasure from the idea of taking care of themselves and consuming a food product that is health enhancing [14]. As a result, there has been a huge incline in the functional food industry worldwide, including Ireland, and noticeable enthusiasm surrounding health and wellbeing among consumers and the media.

Based on the above facts, the aim of the study was to investigate key ingredients applied in the health and functional foods and identify new ingredients that could potentially be used in the functional food production. To better understand what drives Irish consumers to decide which functional foods, their attitudes and perception behind choices was also explored.

## Methodology

Secondary research was carried out to evaluate past literature and background and starting point for the study. The research methods used for this study were both qualitative and quantitative. Quantitative research gathers numerical data, which is measured mathematically, statistically or numerically and is used to formulate facts and uncover patterns within research. Qualitative research is subjective in its approach as data gathered is used to understand human behaviour and the reasoning behind it. Questionnaires use both quantitative and qualitative research, and with their use, consumer perception, behaviours, use and knowledge were analysed with regards to past literature studied and the main objectives of the research project.

## Sample selection

The total number of samples involved in the survey was 128, which includes 30 males and 98 females, from the ages of 16 to 60 years. The sample population was selected as it covered a variety of consumers who are involved in the purchase food products. The variety of participants provided the data collected with a level of significance and broad view of consumers and research objectives.

## Ethical considerations

While conducting the survey, it was important to ensure that no offence was caused through conduction or question phrasing. Each participant was made aware that all information regarding their survey was anonymous and would remain confidential. No opinions, beliefs or thoughts expressed by participants within the survey would be exposed. Each participant was made aware that they were not obliged to take part in the survey if they did not wish.

## Methods of distribution of the questionnaire

The questionnaire was distributed by social media platforms, emails and messenger forums. These platforms were used as they

are a quick and easy way to disperse a survey to a variety of people. The survey was designed using the online provider called survey nuts. With the use of this website, 12 questions were formed to collect specific data particular to each research objective. The questions were a mixture of demographic, open-ended, closed-ended and multiple-choice questions, to gather as much specific information as possible from each participant. Each question was marked with an asterisk, as indication that an answer provided was necessary. This was done to ensure complete data was obtained from the survey, and that overall data could be efficiently evaluated. After 7 days timeframe and distribution of the survey within the chosen platforms, the survey was closed, and data were collected and obtained for analysis.

## Limitations of the questionnaire

Despite the numerous benefits with the use of a questionnaire when gathering data, there are also limitations involved, such as: Question may not be fully understood. No way to determine how much thought a participant has given. People may read differently into each question and reply based on their own interpretation. What appears 'good' to someone may appear 'poor' to someone else. Therefore, is a level of subjectivity that is not acknowledged?

## Instructions to participants

Participants were asked to complete the survey as efficiently and accurately as possible. A definition and explanation of functional foods were provided at the beginning of the survey, to give participants an idea of what the survey was referencing to. Participants were aware that all data gathered was anonymous. They were informed that they had no obligation to complete the survey and they could opt out at any time. Participants were encouraged to be as thorough and informative as possible when providing answers.

## Analysis of questionnaire

After completion by a sufficient number of participants, the survey was closed, and the results were gathered and analysed. The results were analysed individually and with regards to each research objective, and as a study overall. The data was organised and placed on a table, to allow further analysis and drawing of conclusions.

## Results and Discussion

Participants general information shown that results from the demographic questions within the questionnaire displayed a variety of characteristics regarding participants who took part within the survey. Data obtained from the questionnaire was gathered from participants who were mostly female at 77%. Over half of these participants were 18-24 years of age and just under one fifth between the ages of 46-60, displaying that the majority of participants who took part in the survey were of a mature age. Participants were well educated with a total of 27% having obtained some form of degree and 57% having completed or currently attending college. This displays that participants were well educated as no participants had no level of schooling, and a total of 84% were ongoing or had completed some form of third level education. A total of 57% of those who took part in the survey were employed or self-employed with 44% not working or currently a student. This displays that just over half of participants were earning some kind of independent income with just over two-fifths currently have no independent income. Demographic factors are vital when analysing data as gender, age, education level and job status all

play a role in consumer food choices. The gender affects food choices of consumers as women generally have a greater concern when it comes to food choices regarding their health and appearance in comparison to men. Consumers of particular ages, i.e., 18+ years, have more knowledge and control in the food choices they purchase and consume, in comparison to many under 18 years. Education plays a role, as those educated on the diet and the effects it has on the body, may make more health-conscious decisions with regard to purchasing functional foods, in comparison to those who a lower education level. Job status plays a role in a consumers choice as their income greatly affects the foods they buy and consume. Participants may view some functional foods as too expensive to purchase so they opt for foods of a cheaper price point. Those employed for wages may not view functional foods as an expense, as price is not a priority due to the higher income they receive.

### Consumer perception of “functional foods”?

For consumer perception of “functional foods”, we asked participants

1. What is your perception of “functional foods”?
2. Do you regularly purchase any food items primarily for their health benefits?
3. Would you ever purchase a food product containing an ingredient that you have heard of, but are unaware of its exact health benefits?
4. Which of the following food ingredients would you purchase food items containing?

From participants respond (Table 1), it can be concluded that participants generally have a good perception of functional foods.

Ingredients Selected	Results
Minerals and vitamins	78%
Omega-3 polyunsaturated fatty acids	62%
Antioxidants	58%
Dietary fibre	57%
Cod liver oil	50%
Probiotics	48%
Goji berries	47%
Wheatgrass	41%
Seaweed	39%
Ginseng	32%
Plant sterols	25%
Prebiotics	17%
Carotenoids	15%
Kimchi	15%
Hemp milk	10%
Sea cucumber	5%
Pearl powder	3%
None of the above	3%
Other (chia seeds)	1%
Amaranth	1%
Kohlrabi	1%
Arame	1%
Sea horse	0%

**Table 1:** Results showing participants purchase of functional foods containing specific ingredients.

A total of 86% perceived them as “like”, “good” or “beneficial for health”, with 14% perceiving them as “bad”, “expensive”, “a gimmick” or “unusual”. 72% of participants regularly purchase food items primarily for their health benefits with 85% of participants purchasing these food items, despite not having full knowledge on the health benefits they exert. In terms of ingredients, participants chose ingredients that they would purchase food items containing. The top ingredients selected, i.e., “minerals and vitamins” 78%, “omega-3 polyunsaturated fatty acids” 62%, “antioxidants” 58%, “dietary fibre” 57% and “cod liver oil” 57%, are all key ingredients used within a wide variety of functional food products, and ingredients we are constantly exposed to on all forms of media.

### Functional foods used by consumers?

For this question “Functional foods used by consumers”, participants were asked 1. Which of the following functional foods have you consumed? Table 2 shows a list of functional food items they consume. From the results it was found that “oats” are the most consumed food items by participants (78%), 77% having consumed “fish”, 70% consumed “energy/sports drinks”, 70% probiotic yoghurt and 61% fortified snack/health bars. These foods in particular have become more and more popular in recent years as a result of an increase in consumer interest and demand. Now more than ever, health and wellbeing are a priority for many consumers and they are more educated in the relationship between the foods and health. When participants were asked how often do you buy functional food items (Table 2); it was observed that 48% of participants consume functional food products more than twice weekly and 21% consume them daily, displaying a regular incorporation and use of functional foods within participants diets.

Functional Food Products	Results
Oats	78%
Fish e.g., salmon	77%
Energy/sports drinks	70%
Probiotic yoghurt	70%
Fortified snack/health Bars	61%
Fortified breakfast cereals	58%
Flaxseed	51%
Fortified milk	50%
Healthy spreads	47%
Fortified juices	38%
Fortified eggs	19%
None of the above	1%
Other (chia seeds)	1%

**Table 2:** Participants consumption of functional foods products.

### Key functional food ingredients are available within the Irish market that are not yet used in functional foods?

In regards to this question, we hoped to find out whether participant knowledge on functional food ingredient health benefits. The participants were asked “which of the following functional food ingredients and their health benefits are you familiar with? (Table 3).

From the results, it was observed that the functional food ingredients least familiar with consumers are phytochemicals, marine bioactive compounds and prebiotics as displayed in table 3. Within the Irish market, there is room for the expansion and use of new functional

food ingredients within food items. There is a promising acceptance among consumers of food items containing ingredients they are not familiar with, as a large number of participants stated that they would consume ingredients whose health benefits they were not familiar with. Within Ireland, there are numerous potential sources of prebiotics, phytochemicals and marine bioactive compounds, which can be incorporated into food items for the creation of new functional foods.

Functional Food Ingredients	Results
Minerals and vitamins	88%
Omega-3 polyunsaturated fatty acids	77%
Dietary fibre	75%
Antioxidants	70%
Probiotics	62%
Phytochemicals	27%
Marine bioactive compounds	24%
Prebiotics	21%
None of the above	3%

**Table 3:** Representing participants familiarity with functional food ingredients.

Sea cucumbers are small invertebrates that habituate the sea and are located in the North and West coast of Ireland. They are full of numerous nutrients and bioactive compounds with a diverse range of health benefits. These include vitamins A, B1, B2 and B3, calcium, magnesium, iron, zinc, selenium, copper, manganese and, more essential amino acids than the contents of any fish. The diverse range of health benefits they exert includes antihyperglycemic, anticancer, anticoagulant, antihypertensive and antithrombotic.

Seaweed is also a rich source of marine bioactive compounds and a variety of nutrients such as iodine, copper, calcium, protein, vitamin K, selenium, folic acid and fibre. It is plentiful in its sources around Ireland, particularly the South-West coast and provides health benefits such as a healthy immune system, healthy cardiovascular function and healthy thyroid function. It reduces the risk of cancer, stroke, cardiovascular disease and delays degeneration of the brain and nervous systems. Both sea cucumber and seaweed are easily accessible and plentiful within Ireland, for the use as new functional food ingredients within functional food items in the Irish market. The health benefits that both of these ingredients exert are all combating issues that are prevalent and problematic currently within Ireland [15].

There is also potential for growth and expansion of new key functional food ingredients with the use of phytochemicals within the Irish market. Kohlrabi, which originates from the same family as cabbage, cauliflower and broccoli, provides a variety of health benefits such as improved vision, digestion, circulation and nerve and muscle function, healthy immune system, prevents cancer, regulates blood pressure, aids weight loss and prevents anaemia. It is plentiful in its nutrient composition containing, copper, potassium, vitamins A, C and B-group, iron, antioxidants and phytochemicals. Similarly, to kohlrabi, kimchi originates from the cabbage family and has an abundance of nutrients and health benefits. These include vitamins A, B1, B2, C, essential amino acids, selenium, calcium, antioxidants, high fiber, flavonoids, isothiocyanates, carotenoids, providing health benefits such as regulating cholesterol, aiding weight loss, promoting digestion with the creation of *Lactobacillus*, detoxifying, preventing cancer, immune system boosting, treating diabetes etc.

Both kohlrabi and kimchi have the potential to be used as new key ingredients in functional foods, for the health benefits they exert, and their accessibility within the Irish market as they can be grown and sourced within Ireland. Prebiotics also have the potential to be used as a new functional food ingredient within functional foods within the Irish market. Referencing back to the study conducted by Román et al. [16], it was found that consumer's perceptions of naturalness within a food product play vital roles in their acceptance and consumption of food products. Consumers strongly associate a "natural" food product or added food ingredient as "healthy". Prebiotics can be naturally sourced in Ireland in plants such as whole grains, asparagus, leeks and onions, and are easily added to foods as they are and are easily transported and stored, and not as light and heat sensitive as probiotics.

## Conclusion

The research has investigated a variety of key ingredients within health and functional foods. Results showed that there is huge room for innovation and expansion of new ingredients for functional food applications. Consumer perception of functional foods was mostly positive, with only a total of 14% perceiving them in a negative way. It was found that the functional foods are regularly purchased by consumers for their health benefits. Consumers purchase functional food items containing ingredients that they have heard of, without knowing their exact health benefits they provide. The majority of consumers had consumed functional food items were generally of an everyday and convenient use i.e., "fortified milk", "fortified snack/bars". These functional food items are heavily advertised making them familiar products and as a result the majority of consumers regularly consumed them more than twice weekly or daily. Substances such as marine bioactive compounds, phytochemicals and prebiotics have huge potential for the use and incorporation as key ingredients into functional food products. Marine bioactive compounds, phytochemicals and prebiotics are widely available within the Irish market and have the potential for innovation, growth and expansion with regards to functional foods and their use.

## Conflicts of Interest

The authors declare no conflict of interest.

## References

- Ravindran R, Sharma S, Jaiswal AK (2016) Enzymes in processing of functional foods ingredients and nutraceuticals. In: Martirosyan DM (ed.). Functional Foods for Chronic Diseases. D&A Diesel Repair Inc, Texas, USA. Pg no: 360-385.
- Drozen M, Harrison T (1998) Structure/function claims for functional foods and nutraceuticals. Nutraceuticals world 1: 18-22.
- International Food Information Service (2009) IFIS Dictionary of Food Science and Technology, (2<sup>nd</sup> edn). John Wiley & Sons, New Jersey, USA.
- Liu RH (2013) Health-promoting components of fruits and vegetables in the diet. Adv Nutr 4: 384-392.
- Roberts J (2014) Functional foods: Providing benefits. The Irish Times, Dublin, Ireland.
- Katan MB (2017) Functional foods and health claims. In: Mann J, Truswell S (eds.). Essentials in Human Nutrition (5<sup>th</sup> edn). Oxford University Press, New York, USA.

7. Grajek W, Olejnik A, Sip A (2005) Probiotics, prebiotics and antioxidants as functional foods. *Acta Biochim Pol* 52: 665-671.
8. Anbudhasan P, Surendraraj A, Karkuzhali S, Ramasamy D (2014) Development of omega 3 fatty acid enriched stable functional foods: Challenges and options. *Int J Innov Res Rev* 2: 1-13.
9. Global functional food market revenue 2017 and 2022 (2017) Revenue generated by the functional food market worldwide in 2017 and 2022 (in billion U.S. dollars). Statista Ltd, London, UK.
10. Bigliardi B, Galati F (2013) Innovation trends in the food industry: The case of functional foods. *Trend Food Sci Technol* 31: 118-129.
11. Zain-ul-Abidin, Saleem S (2011) Effective advertising and its influence on consumer buying behavior. *Eur J Bus Mgmt* 3: 55-67.
12. Jaiswal AK, Samriti S (2016) Enzymes in synthesis of novel functional food ingredients. In: Chandrasekaran M (ed.). *Enzymes in Food and Beverage Processing*. CRC Press, Florida, USA. Pg no: 381-400.
13. Oliveira D, Machin L, Deliza R, Rosenthal A, Walter EH, et al. (2016) Consumers' attention to functional food labels: Insights from eye-tracking and change detection in a case study with probiotic milk. *LWT-Food Sci Technol* 68: 160-167.
14. Küster-Boluda I, Vidal-Capilla I (2017) Consumer attitudes in the choice of functional foods. The consumer's attitude in the choice of functional foods. *Spanish J Marketing - ESIC* 21: 65-79.
15. Deloitte (2017) Global health care outlook, Taking Ireland's Pulse. Deloitte, New York, USA.
16. Román S, Sánchez-Siles LM, Siegrist M (2017) The importance of food naturalness for consumers: Results of a systematic review. *Trend Food Sci Technol* 67: 44-57.



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