

IMPROVING NUTRITIONAL VALUE AND SENSORIAL PROPERTIES OF BAKERY PRODUCTS USING FUNCTIONAL INGREDIENTS

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Abstract

Research is being done worldwide to improve foods with functional ingredients. In the food industry, the stability of functional ingredients and the type of products in which they are added are taken into account. Bakery products are consumed very frequently and can be improved without much technological effort. Functionalization of this kind of staple food is very important for food security purpose. This paper will assess the scientific literature on this field from the last decade and the state of the art will be described. The objective of this work is to make a short review in using functional ingredients in bakery products, which are used nowadays in industry or are in the research and development phase. The paper presents aspects such as: new sources of functional ingredients (pumpkin seed flour, potato flour, chickpea flour, chia flour, hemp flour, coconut flour, banana flour), new bakery products, new processing inputs to obtain functionalised bakery products, and consumer attitude related to these kind of products.

Key words: bakery products, functional ingredients, fortified flour, nutritional value, sensorial properties.

INTRODUCTION

In recent years, there has been a significant increase in consumer interest in the quality and safety of food products (Marszałek et al., 2015).

Functional foods have been defined several times, being the first time in 1980 in Japan as “food products with special constituents that possess advantageous physiologically effects” (Siro et al., 2008).

Such is the example of the International Food Information Council (IFIC) from USA, which states that functional foods are “Foods that may provide health benefits beyond basic nutrition” the Food and Nutrition Board state “Functional Foods as one that encompasses potential healthful products. Including any modified food are food ingredient that may provide a health benefit beyond that of the traditional nutrients it contains” and the European Commission Concerted Action Group of Functional Food Science (FUFOSE) states “Food which could be regarded as functional as being one that has been satisfactorily demonstrated to beneficially affect one or more

functions in the body, beyond adequate nutritional effects, in a way which is either relevant to either and improved state of health and wellbeing and/or a reduction of risk” (Kaur & Das, 2011).

Functional foods represent one of the most interesting areas of research and innovation in the food industry (Jones & Jew, 2007; Siro et al., 2008).

There are five main markets for functional foods, namely beverages, dairy products, confectionery products, bakery products, and breakfast cereals (Pinto et al., 2014). In developing functional bakery products (including bread), it is important to realize that achieving functional food quality does not simply involve delivering the active principle at the appropriate level for physiological effectiveness, but also supplying a product which meets the consumer’s requirements in terms of appearance, taste and texture (Alldrick, 2007).

Studies and clinical trials suggested numerous health effects related to functional food consumption, such as reduction of cancer risk, improvement of heart health, enhancement of

immune functions, lowering of menopause symptoms, improvement of gastrointestinal health, anti-inflammatory effects, reduction of blood pressure, antibacterial and antiviral activities and reduction of osteoporosis (Shandilya & Sharma, 2017).

Additional (optional) ingredients may be used for processing aids which are essential in particular in the bread-making process, in improving the quality and for fortification of bakery products to have more nutritive value (Al-Dmoor, 2012).

Taking into account the fact that bakery products are the most commonly consumed, by all categories of people, as well as for all diseases, it has been studied over time to improve them with certain functional ingredients. The functional ingredients used must cover the daily requirement of nutrients, without worsening the health of people with certain diseases.

THE GENERAL INGREDIENTS USED IN BAKERY PRODUCTS

FLOUR

The flour comes from various types of cereal grains, especially wheat (Qarooni et al., 1989).

Wheat flour of different types, obtained by grinding wheat is the main raw material used in the bakery industry (Leonte et al., 2016). Flour is a finely ground powder prepared from grain or other starchy plant foods and used in baking. (Mudabbar & Shah, 2015). The chemical composition of the flour depends on the degree of milling. Increasing the degree of milling reduces the percentage of starch and increases the components present in the bark such as inorganic ingredients, insoluble fiber and vitamins (Belitz et al., 2004; Hui, 2006)

WATER

The main function of water is hydration. Ingredients must have water in order to function as expected. For example, flour must be hydrated in order to form gluten and for the starch to gelatinize (Sârbu, 2009). It would be impossible to produce a loaf of bread without water in some form. There are several types of water. Hard water produces better quality bread than any type of water. Therefore, water quality used in a food manufacturing plant has to be managed not only with respect to product

safety, but also in view of the capability of production processes (e.g. cooling, heating and cleaning) (Winkler & Nikoleski, 2012). Water itself participates as a reactant in hydrolytic processes. By binding it to food by salt or carbohydrates, it can influence how certain microorganisms grow, improving storage tolerance. An important role of water is to form the texture of food following interactions with proteins, polyglucides, lipids and mineral salts (Popa, 2018)

YEAST

Baker's yeast is a commercial preparation consisting of dried cells of one or more strains of the yeast *Saccharomyces cerevisiae*. Baker's use yeast as a leavening agent in the rising of dough for baking. A secondary contribution of yeast to bread is flavouring and aroma. Baker's yeast is a high volume, low value product (O'Shea, 2005). The fermentation of baker's yeast is strongly directed towards maximum biomass production, no by products such as ethanol are desired and so the fermentations are sectioned to obtain this maximum biomass (Van Hoek et al., 2003).

SALT

Salt (sodium chloride, NaCl) is a unique food ingredient that is used extensively in the home, food service and food manufacture (Beeren et al., 2019). Salt plays a key role in providing typical textural and organoleptic characteristics in a range of foods and hence its removal and/or replacement may have major impacts on quality and processing (Kilcast & Ridder, 2007). Salt is used to taste and to improve the physical properties of the dough. The salt-free dough is soft and sticky (Leonte, 2003). Salt also contributes in controlling and stabilizing yeast fermentation in dough systems. Salt will prevent over-fermentation. Over-fermentation creates dough with excessive gas and sourness, and gives finished baked goods undesirable open grain and poor texture (Michaelides, 2008).

MATERIALS AND METHODS

This study was based on the description and exploration of functional ingredients that can be added to bakery products. Classic bread-

making technology includes flour, water, yeast and salt, without the use of other additives. The bakery technology aims to provide the market with the most digestible products and to bring a high nutritional intake.

The search included recent research articles, mainly about types of flour from different plants, vegetables, fruits, which can be mixed with wheat flour. Flour obtained from pumpkin seeds, potatoes, chickpeas, chia, hemp, coconut, bananas, are those that bring a high nutritional intake to bakery products. These flours were added as functional ingredients, not as a raw material in the product. The study was conducted for flour obtained from various fruits, vegetables, which raises the nutritional value of bakery products.

RESULTS AND DISCUSSIONS

FORTIFICATION OF FLOURS AND BAKERY PRODUCT

Fortification of bakery product refers to addition of certain bioactive or functional ingredients to the bakery product to enhance its nutritional and therapeutic value (Mudgil & Barak, 2020).

In developed countries, the practice of adding micronutrients, such as vitamins B1, B2, B3 and iron, is recognized as an effective way to improve the nutritional profile (Grigoriu, 2019). The main active ingredients supplemented to bakery goods include probiotics and prebiotics (dietary fibres), antioxidants and phenolic compounds (Dziki, 2014). Other functional ingredients are oils and lipids, mineral and salts (Pinto et al., 2014). The ingredients play a crucial role for both the quality of the final product and its shelf-life (Difonzo, 2019).

Table 1 shows the levels of these nutrients which should be present in the fortified food for each 100 calories contained in the food. The FDA (Food and Drug Administration) guidelines also allow nutrient addition to a food intended to replace a traditional food in the diet.

The addition of nutrients to these substitute foods should be designed to prevent nutritional inferiority of the substitute food (Title 21 CFR Part 104, 1980).

Table 1. FDA - recommended fortification levels based on caloric standard (Quick and Murphy)

Nutrient	USRDA*	Level of nutrients per 100 kcal
Protein (PER < casein), g	65	3.25 <u>1/</u>
Protein (PER > casein), g	45	2.25 <u>1/</u>
Vitamin A, IU	5000	250
Vitamin C, mg	60	3
Thiamin, mg	1.5	0.075
Riboflavin, mg	1.7	0.085
Niacin, mg	20	1
Calcium, g	1	0.05
Iron, mg	18	0.9
Vitamin D, IŪ	400	20 <u>1/</u>
Vitamin E, IU	30	1.5
Vitamin B6, mg	2	0.1
Folic acid, mg	0.4	0.02
Vitamin B12, mcg	6	0.3
Phosphorus, g	1	0.05
Iodine, mcg	150	7.5 <u>1/</u>
Magnesium, mg	400	20
Zinc, mg	15	0.75
Copper, mg	2	0.1
Biotin, mg	.3	0.015
Pantothenic acid, mg	10	0.5
Potassium, g	<u>2/</u>	0.125
Manganese, mg	<u>2/</u>	0.2

1/ Optional

2/ No USRDA has been established for these nutrients

*USRDA - Recommended Dietary Allowance (Federal Register 45(18); 6314-6324, 1980)

Due to the excessive consumption of increasingly white flour, valuable and indispensable components of wheat are lost. Nutritionists claim that these lost components can be added to bread and bakery products in the baking phase of the technological process (Szilagyi, 2019).

You can choose premixes with high quality vitamins and minerals with higher levels of homogeneity, flow and stability (Grigoriu, 2019).

The main active ingredients supplemented to bakery goods include probiotics and prebiotics (dietary fibres), antioxidants and phenolic compounds (Dziki, 2014). Other functional ingredients are oils and lipids, minerals and salts, and vitamins (Pinto, 2014). Among these ingredients, probiotics and prebiotics are important in human nutrition because of their influences on the gastrointestinal (GI) microbiota. Probiotics are defined as 'live microorganisms which confer a health benefit on the host when administered in adequate amounts' (FAO/WHO, 2002). Prebiotics are short chain carbohydrates which are non-digestible by digestive enzymes in the upper GI

tract of humans, but are ‘consumed’ selectively by some types of bacteria (typically bifidobacteria and/or lactobacilli). Prebiotics can therefore enhance the activity of those beneficial bacteria (Al-Sheraji et al., 2013). The alleged health-promoting benefits of the aforementioned functional bakery products are diverse, e.g. reducing serum cholesterol and blood pressure, reducing the risk of coronary heart diseases, lowering the glycaemic response after food consumption, treating human intestinal barrier dysfunctions (Korem et al., 2017; Aleixandre, 2016; Quiros-Sauceda et al., 2014)

INNOVATIVE INGREDIENTS THAT BRING FUNCTIONAL CONTRIBUTION TO BAKERY PRODUCTS

PUMPKIN SEED FLOUR

Pumpkin seeds also known as pepitas are flat, dark green seeds encased in a yellow-white husk (Younis et al., 2000). The pumpkin seed contain substantial amounts of macro and micro minerals such as phosphorus, magnesium, potassium, calcium, zinc, iron and sodium (El-Adawy, 2001). In pumpkin seed flour, vitamin E is found in all forms: α -tocopherol, γ -tocopherol, σ -tocopherol, α -tocomonoenol and γ -tocomonoenol (Dabija, 2018). Research has shown that pumpkin seed flour can be used as a functional and nutritional ingredient in bakery products. The replacement of wheat flour with pumpkin flour in a proportion of 33% increased the nutritional and gustatory value of the muffins (Dabija, 2018).

POTATO FLOUR

Potato flour has been associated with the baking of bread for a long time and is known to help maintain the freshness of bread and provide a distinctive flavor. The addition of potato flour improves the interior qualities of bread, such as texture, aroma, and flavor, without significantly affecting exterior attributes (Narpinder, 2011). Potato flour was used successfully in a proportion of 20% to obtain bread, a high percentage of substitution has a negative role on the development of the dough (Dabija, 2018). The use of potato flour in bread results reduction in protein, fat, moisture content. Potato flour in bread increase

in fibre and carbohydrate contents as level of substitution of wheat flour with potato flour increased (Isaac, 2012).

CHICKPEA FLOUR

Chickpea is considered the 5th valuable legume in terms of worldwide economic standpoint and cheap source of legume protein which can be used as a substitute for animal protein (Ionescu et al., 2009). Chickpea flour is a good source of proteins, fibers, minerals and other bioactive compounds and it could be an ideal ingredient for improve the nutritional value of bread and bakery products (Man et al., 2015). The use of chickpea flour in the proportion of 10-20% in the manufacture of bread has led to improved development time and stability of the dough and the values of the parameters recorded on the dough extensograph (Dabija, 2018). Frequent consumption of chickpea flour products is considered an effective tool to reduce cardiovascular risk, type 2 flow, some cancers and obesity (Dabija, 2018).

CHIA FLOUR

Chia is grown commercially for its black and white seeds which are naturally rich in omega-3 fatty acids (FA), antioxidants, dietary fibre, protein, calcium and various other essential nutrients (Ixtaina et al., 2008). Chia is an excellent alternative as it is the richest known botanical source of alpha linolenic acid. It is also a low cost alternative for vegetarians (Ayerza & Coates, 2005). Chia seed flour has properties that can be used to improve the bread processing process, as it counterbalances the main problems caused by fiber during the manufacturing process. Chia flour in the proportion of 10% added to the mixture with wheat flour, can potentially be used to replace hydrocolloids that are often needed to make gluten-free bread, to ensure better structure and increased volume for baked goods, to obtain healthy nutritional products (Dabija, 2018).

COCONUT FLOUR

Coconut is one of the most important commercial crop in tropical areas and usually referred as ‘tree of heaven’ or ‘tree of abundance’. Coconut is also considered as a ‘functional food’ because it provides additional health benefits apart from its nutritional

constituents. Coconut flour is a unique product prepared from coconut residue obtained after the extraction of coconut milk. It is a rich healthy source of dietary fiber which can be used as bulking agents, filling agents and as a substitute for wheat, rice and potato flour at certain levels and the flour can also be incorporated into various food products like baked products, snack and extruded foods and steamed products (Rajendran & Mithra, 2013). It was found that the glycemic index of coconut flour supplemented foods decreased with increasing levels of dietary fiber from coconut flour (Trinidad et al., 2003; Trinidad et al., 2006). It was found that the amount of wheat flour used for noodles making in Asia accounts for about 40% of the total flour consumed, hence coconut flour can be incorporated up to 20% into wheat flour noodles in order to improve its health benefits (Gunathilake & Abeyrathne, 2008).

HEMP FLOUR

Hemp can be used as a raw material in the production of over 40 thousand types of products for the medical, food, textile, paper, construction, aviation, fuel and other lines of industry. The West is seeing a real boom around this culture: not only is it a focus of interest for private businesses, it is also the focus of large-scale government programs (Leizer et al., 2000). Before the hemp is used as a food ingredient, the hull is usually removed and treated seeds have a nutty flavour similar to pine nuts (Muenzing et al., 1999). With about 25% proteins represented by edestin, a highly digestive storage protein, hemp belongs to important source compared to soybean (Tang et al., 2006). Hemp seeds contain 30-32% oil, which is among the best food oils when ranked by their fatty acid profile. Fatty acids participate in the synthesis of prostaglandins, leukotriens and tromboxans, which regulate important bodily functions: arterial blood pressure, individual muscle contractions, body temperature, trombocyte aggregation (Callaway et al., 1996). The quality of the bread obtained by adding 15%, respectively 20% of partially defatted hemp flour was similar to that obtained from whole wheat flour, having a higher nutritional value, ensuring a higher intake of important nutrients, such as protein,

macroelements, microelements, especially iron. (Dabija A., 2019).

BANANA FLOUR

In Malaysia, not only consumed fresh, bananas are also often processed into several products such as banana crackers, dried banana chips, banana cake, etc. Earlier studies had revealed that banana contained antioxidant substances. Besides that, banana products (BP) also has been found to contain a potentially high amount of dietary fiber (Emaga et al., 2007; Wachirasiri et al., 2008). In addition, it has also been found that banana peel exhibit antibacterial and antifungal properties (Jain et al., 2011; Mokbel et al., 2005; Okonogi et al., 2007). In a study, Nasution (2012) indicated that banana peels contain valuable functional ingredients for human consumption, especially to be incorporated in bakery product such as wholemeal bread. The study was aimed to investigate the effect of substitution of wholemeal flour with banana peel flour on several properties of wholemeal bread. In obtaining bakery products, research was carried out to partially replace wheat flour with banana flour. Thus, by using banana flour in the bread recipe in the proportion of 10%, 15%, 20%, 25% and 30%, the finished product contained a large amount of potassium and fiber, a higher amount of polyphenols and improved antioxidant properties compared to bread obtained only from wheat flour (Dabija, 2019).

CONSUMER INTEREST IN NEW BAKERY PRODUCTS

Consumers show preference for certain foodstuffs considering the sensory, nutritional and health quality aspects, the same as personal preference and other elements (Pescud & Pettigrew, 2010; Luchs et al., 2011; Mason et al., 2011). Among consumers, the awareness and perceptions of older adults in relation to functional foods is of particular interest, as this population could greatly benefit from the incorporation of functional foods into their diets (Paulionis, 2008).

Nutrition information sources on food labels, particularly health claims, are a valuable consumer educational tool that could influence acceptance of functional foods. Consumer

studies have demonstrated that the presence of health claims on functional food labels results in more favourable attitudes towards functional foods and has a positive influence on consumers' perceived healthiness of functional foods (Sabbe et al., 2009). According to *Mordor Intelligence* forecasting, the global energy and functional food market is set to grow at a CAGR of 4.9% between 2019 and 2024. Plant-based, nutrient dense, prebiotic, probiotic, wholegrain, keto, collagen the healthy living market has soon become saturated by many different functional food types, each offering myriad health benefits, functionalities and flavors (Carnnet, 2020).

The main trends in 2015 were: consumption of products with protein additives (vegetables and animals), which address several consumers, such as the elderly and athletes; weight management and well-being; gluten-free products, the area of interest expanding to healthy consumers (Mohan, Culețu, 2018).

According to the study conducted by *Mordor Intelligence*, the following trends were observed globally. In *Fortified bakery market - growth, trends, covid-19 impact, and forecasts (2021-2026)* North America Dominate the Fortified Bakery Market. Global fortified bakery market is primarily dominated by North America followed by Europe, where the bakery products are considered as a staple food. The Chinese and Indian population are too increasing their demand for fortified bakery products, which are preferring high nutrition level despite being high on cost. The rising young population, along with busy, on-the-go lifestyles often dictates a need for quick meal, many opt for fast food options that are low in calories and high on health benefits and taste too. The Indian consumers want high nutrient content along with the taste such that they want full value for money on their fortified bakery products. Exploring bakery experience - with both global and regional tastes, nutritional authentic preparation method are on the rise in the developing countries, like India and China.

CONCLUSIONS

Research has shown that the use of fruit and vegetable flours (as pumpkin seed flour, potato flour, chickpea flour, chia flour, hemp flour,

coconut flour, banana flour) can improve the nutritional qualities of bakery products, as they have a high content of nutrients such as (vitamins, proteins, lipids, carbohydrates).

The appropriate formula for introduction into the technological process must be found, so that their incorporation leads to finished products accepted by consumers.

New techniques or methods need to be explored to improve the stability of the functional ingredients used in fortifying bakery products.

The different ingredients assessed in this review have a high intake of nutrients, which are able to enrich the final products.

In the last decade, a number of ingredients have been launched that are considered innovative and that meet consumer requirements for certain customized products. Thus, it was necessary to implement new technologies in the bakery industry.

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