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Insight into the Technical Challenges of Functional Bakery Products.

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Abstract
Healthier food products that prevent diseases and improve health are on accelerated demand in the foods market. Nowadays, the bakery industry getting involved in improving the health attributes in their product by incorporating functional ingredients in it. Bakery products are one of the important choice because of its versatile use, Different active ingredients can be supplemented into a bakery product to produce functional food. However, the preservation of the functionality even after processing, availability of the components in the body and extent of functional effect still remains a challenge for food industry. The main objective of development for functional foods are associated with gastrointestinal health and body immunity, prevention of cardiovascular diseases, prevention of cancer, obesity, insulin resistance , control of diabetes, and many other mental and physical performance. A deeper understanding of the underlying interactions between functionality and health effect is highly to be explored further. Also new innovative approaches are required for retention of maximum functionality in the baked products for the highest benefit of functional food.

Keywords: *Functional food, baking, probiotics, prebiotics, synbiotics*

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I. Introduction

In recent years, food sector is getting a rising demand of safer and healthier food from the consumers. In response, food scientists and industry started working on the design and development of more nutritious food, which can provide an extra health benefit to its consumer, (1). The beneficial health effect of food can be enhanced by incorporating various functional components in it. carotenoids, dietary fiber, fatty acids, flavonoids, isothiocyanates, phenolic acids, plant stanols and sterols, polyols, prebiotics and probiotics, phytoestrogens, soy protein, vitamins and minerals are considered functional components from various other sources of food. It can be incorporated in the bakery products as functional components and the bakery products can be used as their vehicle or carrier(2).

Beside their health properties the incorporation of functionality can bring various technological changes to the food characteristics. like the functional foods might have a varied texture, viscosity, spread ratio, specific volume, sensory properties like overall taste, flavour and aroma(3).

The objective of writing his article is to look into fact that beside technical challenges in processing how much retention of functionality is possible in baked food. And to look into the matter that when a functional food is actually eaten how much therapeutic effect it can provide in our body.

Functional foods use worldwide and their known benefits

Functional foods are defined for the first time in 1980 in Japan as "food products with special constituents that possess advantageous physiological effects" (1), however still a proper consensus is yet to develop according to its health effect. But in reality scientific intervention and legislative modifications are highly required to be sold legally among consumers. Definitions are much broader but they need to be mor specific. However, to be considered as a successful product, it must meet certain physical quality parameters as well as a good sensorial acceptance from the consumer side. (2,3). Here we include some of physical and sensorial properties that may affect the producyt quality and acceptance. (4).

Four major types of functional foods exist, which are: fortified products, enriched products, supplemented products and altered commodities. Fortified products are those having additional nutrients in their composition, enriched products are developed by adding additional nutrients or components that are not found normally in that food source. An altered product is one in which non-beneficial components have been removed, reduced, or replaced with another component with beneficial effects. Supplemented or enhanced products are products in which one of the components has been naturally enhanced through special conditions or supplemented for a specific purpose (3,4).

In this article The terms related to food definitions are used in the International Food Information Council (IFIC) from USA, CODEX, FDA and FSSAI which states that functional foods are “Foods in its natural or modified form that may provide health benefits beyond basic nutrition”, according to Food and Nutrition Board Functional foods encompasses potential healthful products, including any modified food or 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” (2.3). These regulations cover eight categories of Functional foods, namely, Health Supplements, Nutraceuticals, Food for Special Dietary Use, Food for Special Medical Purpose, Specialty food containing plant or botanicals, Foods containing Probiotics, Foods containing Prebiotics and Novel Foods(9).

A major sector of the consumer is becoming aware that food is related to their health (1). Food that we eat not only provide necessary nutrients but also to prevent diseases and improve physical and mental health. In this regard, functional foods has very important role to play. Actually “functional foods” can be definite as “foods that in its original or modified form may provide many or specific health benefits beyond basic nutrition” (3). The functional foods popularity is growing rapidly. Foods can be enriched or fortified with Vitamin C and E, folic acid, calcium, iron, zinc, omega-3 fatty acid, phytosterol, soluble fiber and micronutrients such as polyphenols, carotenoids etc to develop functionality. When consumers consume a functional food or drink, the bioactive constituents are released from the matrix, metabolized though digestive enzymes, absorbed into the bloodstream, and transported to their respective target tissues. However, bioavailability of the ingested nutrient that is available for absorption in the gut are related to the various intrinsic factors. And different health conditions like pregnancy chronic diseases. Among mineral a classic example is iron absorption. Dietary iron comes in our body either in nonheme (nuts, beans, vegetables) and heme (fish , meat). The availability of heme iron is 14-18% while non heme iron is less than that. (6).

The possibility that the bioavailability of vitamin C from natural sources might be different from that of synthetic was investigated in two human studies, and no clinically significant differences were observed. In particular, Gregory (7,8) demonstrated that vitamin C derived from orange products or cooked broccoli is equally bioavailable. A controversial interference with vitamin C bioavailability was observed when in food matrix both vitamin C and flavonoids are contained. Uchida “et al.” (9). Showed a significant reduction in urinary excretion of vitamin C in the presence of flavonoids whereas Jones “et al.” (10). Observed an increased level of vitamin after consumption of flavonoids rich juice such as kiwifruit and blackcurrant. Among phytochemicals with functional properties, carotenoids and flavonoids are predominant. Carotenoids are enclosed in plant cell walls and cell organelles. Their bioavailability may be also influenced by cooking, fat content and by the presence of fibers (11). Carotenoid release from the food matrix can be enhanced by cooking or freezing however, the literature on the effect of cooking and processing is controversial (11,12). A low bioavailability was increased with an synergistic effect of flavonoids. For example, urinary excretion of anthocyanins was 43%. Sometimes opposite effect may occur. Flavonoids with complex structures and larger molecular weights can reaching out to a bioavailability may be even lower (13). RodriguezMateos “et al.” (14).

How to estimate functional benefits of food

Functional ice-cream, functional biscuit and bread, fruit juices, whey drink, beverages, functional and fortified foods like fortified flour, chocolate, fortified yoghurt and other dairy products like cheese paneer are already in the market. The claim for a functional component is already there as well as for bakery products (13,14).

But the reality Different types of functional food products and their claim for functionality may be far apart from the claim. Because the functional components might have some reasonable alteration in their chemical properties during processing of the food which may lead to change in the functionality and extent of the claimed health effect of the functional food(13).

In most of the cases in vivo or ex-vivo results are required to demonstrate the exact functional effect. Claims like immune boosting effect and many other health effects are really required to be backed by the clinical backup of data to validate this kind of claims. But in realty the claims are actually done either on the age old belief or thoughts(14).

Incorporation of functional components in bakery products and physical properties challenges

In this regard we will enter directly into the area of baked products. The components used in the baking product can act as a potential carrier for the various functional components. The components can be a natural carrier or it can be an enriched carrier. The ingredients, such as the flour, fat, and salt as well as the additives such as emulsifiers, preservatives, and oxidizing agents are used can be potential functional components themselves. The processing aids such as lipases, proteases and xylanases are also used (15).

Physical and Sensorial properties of functional bakery products

A number of research in the field of bakery products, involving the design and development of new products made from non-traditional flour sources and/or the use of composite flours. (16,17). Modifying its physical properties, cost reduction, and meet the consumer satisfaction in terms of sensory attributes. (Awolu et al. 2015), while providing the potential functionality.

With composite flour the physical characteristics of dough and bread are modified and different parameters are needed to be evaluated to successfully design of a functional bakery product. When compared against successful marketed products through a reproducible methodology, the outcome can be predicted to have a potential success in the market.

Physical properties like water absorption capacity (WAC), oil absorption capacity (OAC), foaming capacity (FC), emulsion capacity (EC) and emulsion stability (ES) (18,19) are required to be checked that will help to predict the physical and mechanical behavior of the flour and the dough when developing the product, for instance, a flour with a high WAC will require the addition of more water to achieve the desirable consistency of a flour with a lower WAC. These are the key predictors for their mechanical properties which could serve as basis for the final quality of products.

Depending on the potential functionality of the alternative flour, the dough might develop different mechanical and physical properties. In a number of studies made to evaluate the optimal percentage of combination of a wheat-taro or wheat- tapioca, wheat oat or wheat - soyabean composite flour used to made biscuits, properties measured in alveograph such as extensibility, rupture pressure, strength and elasticity which are index of fitness of that dough for an industrial processing upgradation. Taro or tapioca has shown to play a role in the reduction of high blood pressure, having a potential functionality. It was concluded that up to 10% taro substitution could be used and have optimal properties for development of baked goods (20,21).

Functional properties of flours from some other non- conventional sources have been studied along with their physical and chemical composition parameters. Banana peel was processed into flour; its swelling power, solubility profile along with WAC and OAC were measured(22,23). These parameters resulted higher than expected and greater than other high fiber food products such as oat bran, rice bran, soy flour and wheat bran, which suggests this flour would provide the benefits associated with high fiber consumption. Researchers concluded that banana peel is suitable to be used as a functional ingredient due to the high fiber content as well as the WAC and OAC concerned (24,25).

Functional properties of flours as well as chemical composition can be modified by pretreatments, like starch pre-gelatinization, cause protein denaturation, Maillard’s reaction enzymes inactivation (26,27), as per their specific needs.

Sourdough technology to develop potentially beneficial functional bakery products.

The probiotic bakery product an act as potential functional food source. The formulation of potential functional probiotic bakery products needs to be modified due to the high temperatures condition of baking. Which can eliminate all the probiotics through the baking process. The sourdough technology can provide probiotic benefits by incorporating bioactive compounds derived from dough fermentation. Sourdough is a mixture of wheat or rye flour and water, fermented by lactic acid bacteria, with or without yeasts (28,29). where the benefits of probiotics can be achieved without the actual delivery of live probiotic cells (30). It is important to note that most research done in this topic, cover more the nutritional value rather than its physical parameters. Sourdough provides with incorporation of wider range of aroma, flavor, and texture and increased shelf-life due to higher content of organic acids, which can be a result of either biotransformation such as: proteins, essential amino acids, essential short chain fatty acids (SCFA) or biosynthesis for example, of vitamins(31,32).

Since sourdough fermentation can be done in both aerobic and anaerobic conditions, this has an influence of the outcome of its chemical composition as well as its structure in baked goods. A fermentation in both aerobic and anaerobic conditions using *Lactobacilus casei* N87 and a commercial yeast culture was conducted. The effect of acidification was evaluated, as well as the final biomass available in each sourdough. After 24 h, *L. casei* N87 in aerobic conditions showedalmost similar ph 3.5 $\pm$0.05 Out of the original 8.1 log cfu/g inoculated cells, both conditions showed an increase in biomass. However, the aerobic condition showed a greater biomass increase, to a total cell count of 10.5 ± 0.21 log cfu/g against the 9.5 ± 0.29 log cfu/g of the anaerobic condition. These results indicate that aerobic conditions could lead to higher performance in sourdough elaboration by obtaining higher probiotic biomass, as well as a higher amount of bioactive compounds (32,33).

Flour enrichment with different components to enhance functionality

Soy Flour, Sweet Potato Flour and Flaxseed contains Bioactive ingredients such as phytochemicals, Omega-3 essential fatty acids, Lignans antioxidants, fiber, polyphenols have a large impact in human diet and health. Phytochemicals are naturally found in plants and fruit including flaxseed and soybean. Soy flour offers a nutritious baked treat, diabetic friendly, gluten-free, dairy-free and cholesterol free. Utilization of soy flour (5%

and 10%) and flaxseed (15%) in yeast bread had been done by Comfortis and Davis (3) to evaluate their effect on quality of the bread.

Some of the Whole Grains like Buckwheat, Amaranth, Quinoa and Rye Whole grains and fiber are very effective ingredients to incorporate into baking formulations. Recent technology is under development on health improving ingredients without sacrificing basic acceptability, flavor and taste.

Fruits and Fruit pieces or even Wastes in the candied form of Ho et al. (22,34) in the bread or cookies containing banana pseudo-stem flour d greater total phenolics and antioxidant activities than the normal bread. Utilization of apple skin, guava pieces, orange peel, apricot, grapes skin i.e. the by-products of jam and jelly manufacturing industry could act as beneficial health food ingredients(35).

Olive oil contains monounsaturated fat along with antioxidants can improve flavor and textures to foods and impart healthy component(36). Baking with olive oil instead of butter reduces the amount of cholesterol and saturated fat in formulations. Olive oil produces mouth-feel with more lightness in breads, brownies, biscuits and cakes. Wheat products enriched with beta carotene sources along with antioxidants normally show higher carotene stability during baking process. Beta carotene added in both bread and crackers indicated a greater retention during mixing, proofing (breads), sheeting or even during baking of the dough(37,38).

Functional property enrichment in bread : Studies of Functional Probiotic bakery products

Few flours from alternative sources have been studied to determine their prebiotic potential or properties. A number of research are on the way to evaluate prebiotic potential of flours from alternative sources, several functional, sensorial and physical properties are also needed to determine to establish the physical behavior of the flour of interest during processing and consumer acceptance(39,40).

Yacon (*Smallanthus sonchifolius*), Yam (*Dioscorea alata*), *sweet potato (*Ipomoea batatas*)* flour has shown high prebiotic properties in guinea pigs due to its high fructooligosaccharides and chlorogenic acid content (41). Green dwarf banana peel and flour from the mesocarp(*Musa* sp. AAA) are also helpful in preventing intestinal inflammation in murine colitis model due to its high content of resistant starch (RS) (42). Most of the research done in the development of potential functional bakery products, are developed by including probiotics and prebiotics to show an enhanced health benefit to the consumer.

Several studies have been done regarding the use of sourdough technology for the development of potential functional probiotic baked goods. One of probiotic bacteria *Bifidobacterium pseudocatelunatum* ATCC 27919 could be used in the development of a potential functional bread with enhanced nutritional values. It also helped in digesting phytic acid from different sources of plant. Like from millet flour, the phytic Acid content can be reduced by enzymatic hydrolysis and reducing the antinutritional component causing negative effects in mineral absorption in humans and animals(41.43).

Lactic and acetic acid lower the rate of starch digestion and absorption in a preventive way and the gastric emptying rate. *B. pseudocatelunatum* ATCC 27919, has shown to produce organic acids such as lactic and acetic, as well as phytases. It was observed that *B. pseudocatelunatum* can be used to develop functional bread through sourdough technology with increased organic acids and lowered phytic acid. These products are effective in lowering glycemic index, and improve mineral absorption and improved digestion rate. But the quality parameters are almost well retained with proper crust colour, crumb colour and texture, only the specific volume was found to decrease by 10-15% with increase in the firemness. (decrease from 2.46 to 2.22 mL/g) and firmness (increase from 2.61 to 3.18 N). While further studies shows that lactate and acetate produced is beneficial for human health, or on the preservation quality of the food(44).

It was found an increase of 1.85 ± 0.87 to 10.55 ± 0.54 and 3.05 ± 0.05 to 22.89 ± 0.24 µmol/g, respectively. This increase could lead to improved starch digestibility (Sanz-Penella et al. 2012), providing an additional health benefit to its consumer. In a different study targeting a specific group of patients, sourdough technology can be used in the development of a bread for blood pressure reduction, and enhanced production of γ-aminobutyric acid (GABA) and angiotensin I converting enzyme (ACE) inhibitory peptides. This achieved through sourdough fermentation using *L. brevis* CECT 8183 in presence of proteases. GABA production using sourdough technology was found to be increased sevenfold than control bread (4.99 ± 0.07 to 5860.93 ± 176.59 mg/100 g dry matter). These results suggest that the consumption of 80-100 g per day of that bread would be enough to display health benefits to the consumer (42).

Few more studies have revealed that the sourdough technology has potential to enhance the product's shelf-life. In a study researchers showed that three Different *Lactobacillus* species like *L. amylovorus* DSM19280, *L. brevis* R2Δ and *L. reuteri* R29 were used in a study to evaluate antifungal carboxylic acids production in wheat sourdough.

The acid concentration may vary from species to species. After 48 h fermentation, it was found that *L. reuteri* R29 had the greater amount of 2-hydroxyisocaproic acid and 3-phenyllactic acid acids 360 and 194 mg/kg respectively, however, sourdough breads with *L. amylovorus* DSM19280 showed an increase in its maximum average shelf life by 6 days without showing any sign of fungal spoilage. To compare with artificially acidified sourdough authors did used 1.4% w/w with acetic and lactic acid in 4:1 proportion and allowed to digest the dough. Authors concluded that if *L. amylovorus* DSM19280 and the artificially added acids are coexisted they can provide a synergistic effect between the compounds produced by ones that show an increase in its average shelf life (43,44). Further research is done to study study the functionality of the previously mentioned organic acids, as well as sensory acceptance.

Sourdough technology can be used for reducing the acrylamide production in baked goods. During baking, acrylamide formation is a very common phenomenon due to Maillard's reactions between the carbonyl groups of reducing sugars and amino group of free L-asparagine. Sourdough probiotics fermented with *L. casei-casei* DSM 20011 and *L. reuteri* DSM20016 were used to prevent the Maillard formation by breaking down acrylamides, sangak and bread roll. These results suggest that sourdough fermentations not only provide an increased number of bioactive compounds, but also could make baked goods safer to consume.

Sourdough technology can also be effective for improving the baking quality of flours of alternative sources like oats, maize, soya flour, and many agricultural or vegetable waste which are the contributors of RS and micronutrients like minerals. When a lactobacillus strain is like *L. plantarum* or *L.* brevis is mixed with yeast *Saccharomyces cerevisiae*, in the dough the specific volume of the final product was found to increase by 15-20% with a satisfactory sensory attribute. which is effective for application of higher RS content in dough (45).

Probiotics can also be incorporated in baked products in alginate or whey protein film coated on the surface of the baked product the coating can be place at the onset or middle or end of baking. The design parameters can be modified accordingly in the oven conveyer or in the batch process. Also, probiotic edible film of glycerol acting as plasticizer with 50% polysaccharides total solids, plasticized by heating at 80 °C for 30 min. can be applied by uniformly brushing bread's crust(42).

In many of the studies it has been shown that Cell's viability was a major concern in this kind of product. Bread samples were microbiologically tested 2 h after baking and up to 7 days in storage. Cell viability initially decreased with 2 days then reaches the log phase and increased till 7th days. During these times the probiotics in bread reaches 6–8 log cfu/g of probiotic viable cells in bread's crust. After an in vitro gastric ingestion, it was found that a single bread slice, 30–40 g was enough to deliver up to 6.91 log cfu/portion, which is able to meet WHO recommended viable cell counts for probiotic bacteria (44).

Immobilization of probiotics in bakery products and its efficacy

microencapsulation process where a cell or material can be entrapped for its immobilization, protection, controlled release, structuration and proper long-term functionalization. This approach is highly effective for preventing probiotics against different adverse conditions. In the context of the present article, the microencapsulation of probiotics is another approach to increase cell viability in foodstuffs and deliver their health benefits by protecting them from adverse conditions such as high temperatures, shear stress and gastric transit. (45): Various methods like Prilling, spraying, emulsification can be used for microencapsulation of probiotics

Microencapsulated *L. paracasei* E6 and *L. paraplantarum* in a combination of whey protein isolate, Gum Acacia and Gum Arabic B1 were microencapsulated and treated under different heat stress conditions. Microencapsulated probiotics showed higher survival rate under stress conditions than free probiotics; studies showed an increase in survival rate by almost 50% in a simulated gastric environment. Most of the encapsulated organisms showed withstand of thermal stress at a temperature as high as 100-110^{o}C, (46), while baking temperatures usually are 200 °C for 20–30 min. But still the encapsulation technique is showed quite promising result in better survivability of the organisms. Another study with *L. acidophilus* LA1 was microencapsulated using sodium alginate and starch. It was found that the microorganism could survive well enough in simulated gastric conditions (pH 1.0, 1.5 and 2.0), with high salts concentrations (1.0, 1.5 and 2.0%) and up to 90 °C (47). Further research needs to be done to increase the thermodurability of the probiotic bakery products.

On a similar study which combined both edible film and microencapsulation technology, *L. acidophilus* was microencapsulated and sprayed into breads before baking. Partly-baked breads were sprayed with the film and fully baked at 180 °C during 15 min on a preheated (220 °C) convection oven. Three levels of coatings were created, from an initial concentration of 4.83E+08 UFC/bread, after 24 h there was found 1.70E+06, 1.15E+06 and 1.22E+06 UFC/bread respectively. These results show that even after baking, viable probiotic cells can be found in bread's crust. Its L^* decreased in function of the number of coatings applied, ranging from a 60.5 down to a 55.4, which indicates a browning effect. But, sensory evaluation through a trained panel showed that there was no significant difference in neither of their evaluated parameters (48,49).

This study suggests that probiotic edible films can be an effective approach into the development of potential functional bakery products that include microencapsulated viable cells. To our knowledge and up to this date, no other study has related microencapsulation to probiotic survival rate during the cooking process in bakery products. This is presented as an area of opportunity that can be exploited and could bring important breakthroughs in this field. This way, the development of baked goods that not only can provide the benefits of sourdough technology, but also the health benefits of live probiotic bacteria entering the consumer system could be possible.

Prebiotic bakery products

A prebiotic is defined as a non-digestible food ingredient that beneficially affects the host by selectively stimulating growth and/or activity of one or a limited number of bacteria in the colon, thereby improving host's health (50,51). Most prebiotics are plant polysaccharides, being inulin and RS the most studied so far.

Regarding inulin, it has been used as a low calorie sweetener, fat replacer and texture improver by increasing viscosity (52,53,54). Inulin's caloric value is 1.5 kcal/g or 6.3 kJ/g, 25–35% of a fully absorbed fructose molecule,(55,56) which represent only a fraction of other sweeteners used, providing a nutritional advantage if used to replace fat and added sugars (55,57).

Studies in potential functional prebiotic bakery products

Heat tolerant Bacteria has potential use in functional bakery product. Probiotic cultures were isolated from different randomly purchased yogurt samples and were identified as Lactobacillus sp., Bifidobacteria sp., and Pediococcus sp. after morphological and biochemical characterization. Heat tolerance of isolates was tested at 60 °C and 70 °C to determine the survival of isolates in conditions similar to commercial cheese production. Lactobacillus acidophilus (S2) showed remarkable heat tolerance among all strains and was therefore selected to assess the probiotic potential. It showed good survival at acidic pH values (2–3). This long history of safe consumption led to the consideration that many LAB strains are Generally Recognized as Safe (GRAS). As early as 1906, LAB were linked to the benefit of human health(58,59).

Lactic acid bacteria (LAB) are a heterogeneous group of Gram-positive bacteria that are comprised of the genera *Lactobacillus*, *Lactococcus*, *Streptococcus*, *Enterococcus*, *Leuconostoc*, *Carnobacterium*, *Oenococcus*, *Pediococcus*, *Tetragenococcus*, *Vagococcus*, and *Weissella* (60). Due to their historical long-term use they are regarded as safe, and some of the species are used as probiotics, as they have beneficial effects on people. Moreover, when describing their characteristics, LAB are often claimed to have a 'generally recognized as safe' (GRAS) status, which confirms their safety(61,62).

To date, only nongenetically modified (nonGM)-LAB strains have been granted FDA approval because they can very well be made thermoduric by genetic manipulation. However, no matter how effective a specific GM-LAB might be, a drawback that stands in the way of its marketing if it has been genetically manipulated; this is mainly due to low consumer acceptance of GM microorganisms (particularly in the European Union (EU)) and regulatory restrictions to their use. At the combined 2018 International Probiotics Association World Congress and Probiota, it was revealed that GM probiotics would be perfect from a scientific point of view, and would probably get registration with the European Food Safety Authority (EFSA). However, the mindset of consumers and industry to GM organisms (GMOs) still prevents their acceptance, and accordingly, only naturally occurring strains obtain approval (adapted from (63,64)).

RS3 may be formed during the baking process due to starch chains re-associating the double helics protein chain and forming tightly packed and retrograded structures structures stabilized by hydrogen bonding. Few recent studies evaluated the effect on RS formation with different concentration spelt flour (*Triticum aestivum* spp. *spelta*) and the physical parameters of dough formation as well as in the breadmaking with different baking times and temperatures. RS increased from 1.18 ± 0.02/100 g all the way to 1.49 ± 0.07/100 g; water to flour ratio was found to be the reason for this increase. Lower temperature and longer baking time (125 °C/4 h) instead of a higher temperature and shorter baking time (155 °C/3 h) resulted in a higher amount of RS to be formed (1.45 ± 0.13/100 g against a 1.26 ± 0.09/100 g) (65,66). These results suggest that RS3 formation in a potential functional prebiotic bread can be controlled by using probiotics in the formulation and processing stage(65).

Most prebiotic bakery product research and development requires focus on nutritional as well as physical and quality parameters of the product and their processing condition. Wheat bran's prebiotic potential is associated to prevention of cardiovascular diseases, colon cancer, obesity, and gastrointestinal diseases. In several studies, the effect of different levels of wheat bran from durum wheat addition within the range of 5 - 30% in sensory, physical and mechanical properties were evaluated by researchers. (67). These results suggest that higher levels of bran can be a relevant way for enhancing functionality with acceptable sensory results.

Addition of inulin can provide functional attributes enhancing mineral absorption in colon due to enhanced nutrition value. Rheological examinations revealed that there is an almost 50% increase in hardness (1.2–3 N), adhesiveness (5–10 N s) and consistency (10–25 N) of the dough, important parameters in bread quality control. The WAC of flour was found to decrease and therefore, the amount of water needed due to inulin's high water retention capacity was lowered (68,69). This result supports the claims that inulin can be used as a texture modifier, which presents an important alternative for non-gluten products.

Prebiotics have shown that applied correctly, not only can match commercial products but also even have better results. In orange cakes with inulin added parameters such as crust brownness, hardness and stickiness increased when comparing with the control cake due to the addition of inulin. These parameters are all related to consumer acceptance of a product, depending on the kind of baked product is desirable. These potential functional cakes were compared against three commercially available orange cakes. Results showed that there was no difference in the acceptance between the functional cakes but they were better received when compared to the commercial cakes in sensory attributes such as appearance, aroma, chewability, texture, flavor and overall acceptability (68,70).

The use of prebiotics also includes enriched cookies with fructo-oligosaccharides (FOS) in 40, 60 and 80% sugar replacement. On evaluation of diameter, hardness, spread ratio and height were found to increase with the increase of the cookies dimeter on baking by 2-5% with same condition. Both height and hardness decreased with increasing FOS substitution(66).

The overall average of acceptability for control cookies was on a 1–9 hedonic scale, with up to a 60% replacement of sucrose with FOS can be done with high sensorial acceptance and can be considered as potential functional cookies (67).

Synbiotic products

Currently researchers are involved into the development of functional products is the combination of both prebiotics and probiotics in the right proportions and quantities, so that the health benefit and product quality both are available. synbiotics can be developed with the intention of therapy rather than their use in formulated food products. (71).

From literature search only few studies were seen for synbiotic bakery product was found to enhance human health. The study was made to evaluate the positive effects that consuming a synbiotic bread might have on the blood lipid profiles of patients suffering from type 2 diabetes mellitus (T2DM). The synbiotic components in bread were *L. sporogenes* along with inulin to improve thermodurability, shelf life as well as physical parameters. Researchers found a significant decrease in levels of triacyl glycerides, very low-density lipoprotein-cholesterol and the improved ratio between total cholesterol over high density lipoprotein cholesterol. This concludes a positive effect on patients with T2DM(72).

The use of symbiotic functional bakery products can provide not only flavors and aromas, but they can be effectively used for patients with diseases such as colorectal cancer and T2DM. (71,72). however further studies are needed in order to obtain more confident results and to be able to gather more information into establishing the mechanisms involved in the reduction of lipid fractions in plasma through a synbiotic therapy (72). However, this study didn’t consider any food science perspective or any kind of sensorial acceptance.

Bioavailability of Functional component of food

But if we look into the food habbit of consumers 1-2 biscuits or cookies a day or 2-3 pieces of bread a day enriched with functional components how much nutrient is actually reaching our organs, that really need strong evidence by clinical research. Bio efficacy is improved through enhanced bioavailability. But due to complex nature of food the bioavailability and efficacy both are the challenging areas to look into. Therefore, several technologies have been developed to improve the bioavailability, including structural modifications, nanotechnology and colloidal systems(73). So, there is still a controversy on the bioavailability of the functional components the literature appears sometimes controversial. For the above-mentioned reasons further studies are necessary to understanding their interactions, metabolism and mechanism of action.

II. Conclusion

Potential functional bakery goods can be used as delivery systems for prebiotics and probiotics without sacrificing either their physical quality or their sensorial acceptance. Consumption of probiotics, prebiotics and synbiotics are highly related to human health. Developing functional bakery products and including them in everyday diet, provide an alternative into the preservation and improvement of human health. However, it is important to note that these products are not to be taken in place of pharmaceuticals. Their best use is being taken on a regular basis which will help improve consumer’s health as acting more as a prevention and synergistically rather than a medical treatment.

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