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PHYBOPLUS® Series

A Fiber-Enriching Ingredient for Food Products

In response to the rising consumer demand for dietary fiber, the food industry is pioneering innovative, fiber-rich products that enhance both flavor and well-being. From breads and cereals to snacks and cookies, these new offerings align perfectly with the growing preference for nutritious and health-enhancing foods. Consumers today seek foods that not only taste great but also contribute to their overall health, driving a significant shift towards fiber-enriched options.

This surge in demand for dietary fiber is reflected in the impressive growth of the global dietary fibers market, valued at $6.73 billion in 2021. With a projected Compound Annual Growth Rate (CAGR) of 9.2% from 2022 to 2030, the market is poised for substantial expansion.

This article explores the critical role of the PHYBOPLUS® Series, a revolutionary starch fiber, as a key food ingredient. We highlight its benefits, diverse applications, and transformative potential for the future of nutrition.

"The PHYBOPLUS® Series offers versatile & high-quality fiber solutions"

that can be integrated into various food products to meet the evolving dietary needs of health-conscious consumers. Join us as we reveal the possibilities of the PHYBOPLUS® Series and its impact on enhancing nutrition and well-being worldwide.

Resistant starch (RS) and resistant dextrin (RD) are types of DF that are not digested by the small intestine. RS can be categorized into four primary types (RS 1 to RS 4). These types vary in their sources and formation processes, and they offer distinct potential health benefits. While RS 1 is physically entrapped within plant cell walls, RS 2 has a granular structure, RS 3 is formed through retrogradation during cooking and cooling, and RS 4 is chemically modified (Bojarczuk et al., 2022).

Dietary fibers (DF) are carbohydrates that cannot be digested or absorbed in the small intestine (Shah et al., 2020). They can be classified into soluble and insoluble fibers (Lattimer & Haub, 2010). Soluble fibers, such as oligogalactose, oligofructose, inulin, β-glucan, pectin, and some types of resistant starch, are fermented by gut bacteria to produce short-chain fatty acids (SCFAs) (Sivaprakasam et al., 2016). Insoluble dietary fibers, such as cellulose, hemicellulose, lignins, arabinoxylans, and some types of resistant starch, do not dissolve in water. These fibers typically enhance the volume of fecal matter and the elimination of bile acids while reducing the time it takes for food to move through the intestines (Mudgil, 2017).

About

PHYBOPLUS® Series

PHYBOPLUS® 2 and PHYBOPLUS® 3 (Insoluble Fiber) are categorized as resistant starch type 4 derived from tapioca, boasting a remarkable fiber content of up to 75%. They are commonly used in solid foods such as bakery products, noodles, snacks, pet snacks, cookies, and desserts. On the other hand, PHYBOPLUS® S85 (Soluble Fiber) is categorized as a resistant dextrin derived from corn, delivering a minimum fiber content of 85%. It is specially formulated for use in both solid and liquid foods, including bakery products, cereals, beverages, dairy products, confectionery, soups, sauces, and dressings.

The PHYBOPLUS® Series offers the potential to promote digestive health and contribute to maintaining healthy blood glucose levels. If you are looking for a way to add more fiber to your diet and improve your overall health, PHYBOPLUS® products are a great option.

Physiological characteristics of resistant starch & resistant dextrin

RS and RD are classified as types of dietary fiber. Despite their distinct chemical compositions, both resistant starch and resistant dextrin confer similar health benefits (Barber et al., 2022; DeMartino & Cockburn, 2020).

Effect on Intestinal Health

In the colon, RS and RD are used as substrates by the gastrointestinal microbes that live there to ferment them and produce Short Chain Fatty Acid (SCFAs) (Barber et al., 2022; DeMartino & Cockburn, 2020). The SCFAs are mainly acetic, propionic, and butyric acid (Deehan et al., 2020) (Fig. 1). Butyrate serves as the primary energy source for the cells lining the colon. Propionic acid and acetic acid reduce the pH in the gut, safeguarding it against pathogenic bacterial growth (Shen et al., 2017). Furthermore, RS and RD are advantageous for maintaining the integrity of the endothelial barrier through the promotion of crypt cell production and the reduction of endothelial atrophy (Ho Do et al., 2021).

Effect on Glycemic Response

Carbohydrate metabolism disorders pose a substantial worldwide epidemiological challenge. They are associated with the onset of conditions such as diabetes and other health issues (Nielsen et al., 2015). Previous studies have found that the indigestion of RS and RD in the small intestine decreases the glycemic index after ingestion, and the fluctuation of postprandial blood glucose is small, which effectively improves the glucose tolerance and insulin resistance of diabetic patients (Aliasgharzadeh et al., 2015; Dainty et al., 2016). SCFAs, generated through the bacterial fermentation of RS, play a crucial role in reducing blood glucose levels by boosting insulin sensitivity and the glucose transporter (GLUT4), leading to increased glucose uptake by muscles (Higgins, 2004; Marsono, 2016).

Effect on Lipid Profiles

Consuming an excessive amount of high-calorie foods leads to elevated levels of cholesterol and triglycerides in the bloodstream, contributing to hyperlipidemia. This condition is a significant risk factor for the development of atherosclerotic cardiovascular disease (Schade et al., 2020). Among the SCFAs generated through the fermentation of RS, propionic acid plays a key role in reducing cholesterol levels and influencing the absorption of lipids and the synthesis of fatty acids (Cheng & Lai, 2000). Moreover, consuming RS and RD in the diet promotes lipid burning, resulting in reduced fat storage and enhancements in lipid regulation (Nielsen et al., 2015; Włodarczyk & Śliżewska, 2021; Zhang et al., 2015) (Fig. 1).

Effect on **Body Composition & Dietary Regulation**

Obesity is a global health concern characterized by the abnormal accumulation of fat resulting from excessive food intake or disrupted metabolism (Abarca-Gómez et al., 2017). RS is resistant to degradation into glucose, resulting in a very low energy yield, estimated at only around 10% compared to digestible starch (Higgins, 2014). RS and RD can decrease food consumption by promoting the release of satiety-related hormones like glucagon-like peptide-1 (GLP-1) and peptide tyrosine tyrosine (PYY) (Włodarczyk & Śliżewska, 2021; Zhou et al., 2008). A diet rich in RS promotes feelings of fullness, extends the duration of digestion, and contributes to weight loss (Maziarz et al., 2017). In conclusion, previous research suggests that RS positively impacts weight management by reducing energy and fat storage while enhancing feelings of satiety (Han et al., 2023; Włodarczyk & Śliżewska, 2021) (Fig. 1).

Effect on
Antioxidant Activity & Immune System

Elevated free radicals are associated with a range of metabolic disorders, and obesity, in particular, is characterized as a chronic inflammatory condition. The elevation of inflammatory biomarkers, including tumor necrosis factor α (TNF-α), interleukin-6 (IL-6), and interleukin-1 β (IL-1β), may contribute to the development of non-communicable diseases (NCDs) (Xu et al., 2020). A recent systematic review provided evidence that the consumption of RS and RD significantly lowered the levels of inflammatory biomarkers, including IL-6 and TNF-α. In addition, elevated activity of antioxidant enzymes, such as IL-10, has been observed (Vahdat et al., 2020; Włodarczyk & Śliżewska, 2021) (Fig. 1). Another potential mechanism associated with SCFAs like butyrate is the promotion of beneficial bacteria with anti-inflammatory properties, such as Bifidobacteria, while inhibiting the proliferation of Gram-negative bacteria (Moore, 2013).

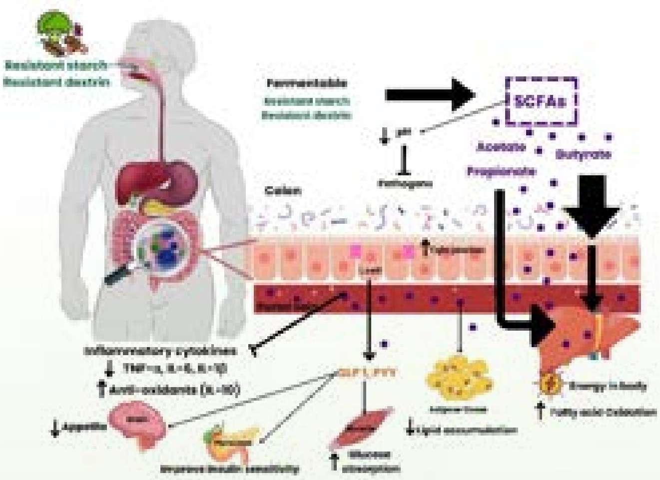

Figure 1. The mechanisms underlying the health

Mastering the Integration of PHYBOPLUS® Series in Food Applications

PHYBOPLUS® Series revolutionizes the way we enhance fiber content in food products. PHYBOPLUS is an exceptional ingredient that not only boosts fiber content for nutrient labeling claims but also helps lower calorie counts.

What sets PHYBOPLUS® apart is its unique combination of features: a white color, non-gritty texture, low water absorption, and reduced caloric content. These attributes make it an ideal choice for a wide range of food applications.

Functional Benefits

of PHYBOPLUS® Series in food

The PHYBOPLUS® Series offers a small particle size, white appearance, and bland flavor, ensuring seamless integration into various food products. It excels in processing, providing crispness, expansion, and improved texture in the final product. Its low water-holding capacity enhances handling during production and contributes to superior texture in the finished goods (Sajilata et al., 2006).

Resistant Starch (RS) offers several benefits in terms of food applications

Improved Texture

RS can be used to improve the texture of food products. When incorporated into foods such as bread, pasta, or rice, it can enhance their chewiness and overall mouthfeel. This can be especially desirable in certain baked goods and pasta products (Walsh et al., 2022).

Extended Shelf Life

Foods containing RS and RD tend to have a longer shelf life due to their resistance to enzymatic digestion by microorganisms. This can be particularly advantageous for products that need to stay fresh for an extended period, such as certain types of bread or snacks (Tester et al., 2004).

Gluten-free Applications

RS can be a valuable ingredient in gluten-free products, helping to mimic the texture and structure of gluten-containing foods like bread and pasta. (Walsh et al., 2022)

Benefits of PHYBOPLUS® as a dietary fiber in food application

The PHYBOPLUS® Series can be used in various food categories to achieve specific functional and nutritional benefits. Here are some examples of how the PHYBOPLUS series can be applied in different food categories. When incorporating the PHYBOPLUS® Series into food products, it's important to consider the specific goals of each application, as the optimal usage levels and processing methods may vary. Additionally, regulatory guidelines and labeling requirements should be followed to ensure compliance with food safety and labeling regulations.

Bakery Products

• High-fiber Bread

PHYBOPLUS® 2 and PHYBOPLUS® 3, tapioca-based resistant starches, can be incorporated into bread formulations to enrich fiber content, prolong the shelf life of the product, and provide a soft texture without affecting its appearance (Fig. 2).

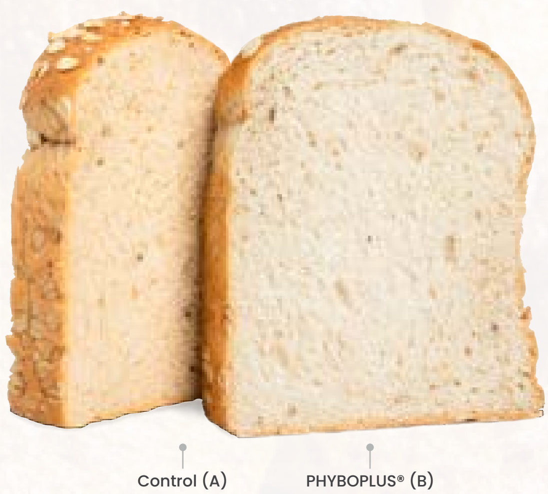

Figure 2. The bread prepared from PHYBOPLUS® Series (B) & control (A)

• High-fiber Puff Pastry

PHYBOPLUS® 2 and PHYBOPLUS® 3 can be added to puff pastry to provide crispness texture (Fig. 3), improve puffing ability (Fig. 4), enrich fiber content and good freeze-thaw stability.

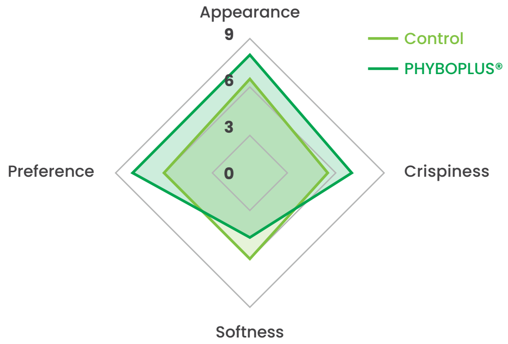

Figure 3. Sensory evaluation 9-point hedonic scale of high fiber puff pastry

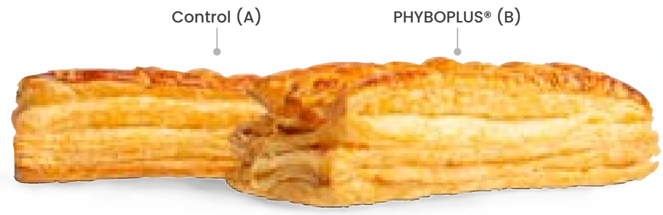

Figure 4. The pastry prepared from PHYBOPLUS® Series (B) & control (A)

• High-fiber Cookies

High-fiber cookie is an example of delicious high-fiber bakery products made from starch fiber. PHYBOPLUS® 2 and PHYBOPLUS® 3 can enhance fiber content, improve meltability, and crispiness in cookie products (Fig. 5 & Fig. 6).

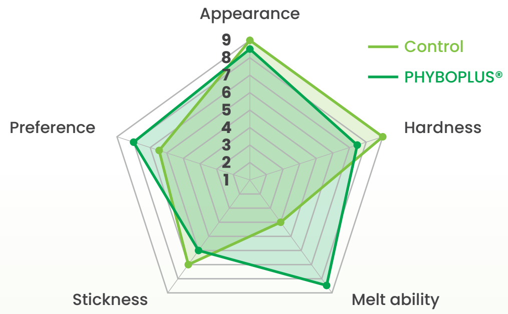

Figure 5. Sensory evaluation 9-point hedonic scale of high fiber cookies

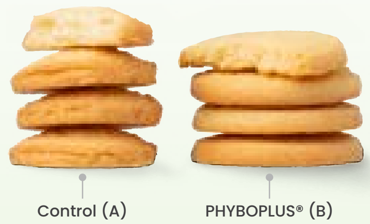

Figure 6. The cookie prepared from PHYBOPLUS® Series (B) & control (A)

- Fiber Fortification in Animal Nutrition

Take care of your lovely pet by adding more fiber to their diet with the PHYBOPLUS® Series. This fortifying starch contains 75% dietary fiber, reduces calories, and provides a stable structure for pet food products. It's the most suitable solution for dog lovers to treat their dogs with care (Spears & Fahey, 2004).

Pasta & Noodles

PHYBOPLUS® 2 & PHYBOPLUS® 3 are added to gluten-free pasta and noodles to improve texture, reduce stickiness, and lower the glycemic index of these products.

- High-fiber Noodles

Adding fiber to traditional noodles is a wholesome solution to boost healthiness. You can enhance your healthy diet with PHYBOPLUS® 2 & PHYBOPLUS® 3, which are applicable for fresh, dried, and instant noodles. PHYBOPLUS® 2 and PHYBOPLUS® 3 help enrich the fiber content, make it easy to process at 10-15% of the flour, reduce calories, and provide a smooth and elastic texture.

Table 1. Dietary fiber content in instant fried noodles

Dietary fiber content	Dietary fiber content	
	Control	PHYBOLUS®
Total dietary fiber (g/100g)	2.17	13.3
% RDI	4.77	29.26
High fiber claim (>20% RDI)	-	High fiber

* Recommended daily fiber intake: 25 grams/day

Animal Nutrition

It's not only humans who desire to live a healthy life; our lively pets do too. Selecting the best and healthiest food for their fluffy family members is now a top concern for pet owners. We have launched new solutions for fiber fortification to help you provide the best nutrition for your beloved pets.

Snack Foods

- High-fiber Rice Cracker

PHYBOPLUS® 2 & PHYBOPLUS® 3 can be incorporated into high-fiber rice crackers to enhance fiber content, provide a crunchy texture, and improve smooth appearance (Sajilata et al., 2005).

- Chips

PHYBOPLUS® 2 and PHYBOPLUS® 3 can be used in the production of potato chips to reduce oil uptake during frying, resulting in a lower fat content (Sajilata et al., 2005).

Dairy Products

PHYBOPLUS® S85, a corn-based resistant dextrin, can be incorporated into yogurt to increase viscosity, prebiotic content, and promote gut health (He et al., 2019).

Beverages

The consumption of beverages is continually trending upward, including pre-mixed beverages and canned drinks. The current trend towards healthier beverage options is also influencing consumer choices.

PHYBOPLUS® S85 is added to juices, smoothies, and nutritional beverages as a dietary fiber source to improve mouthfeel without interfering with the original flavor of the beverage. It has excellent water solubility, provides a clear solution, and can be used as a solid replacer in sugar replacement.

Confectionary

• Jelly Stick

PHYBOPLUS® S85, a corn-based resistant dextrin, can be incorporated into jelly sticks to enrich their fiber content without affecting appearance, taste, viscosity, and with excellent water solubility (Fig. 7).

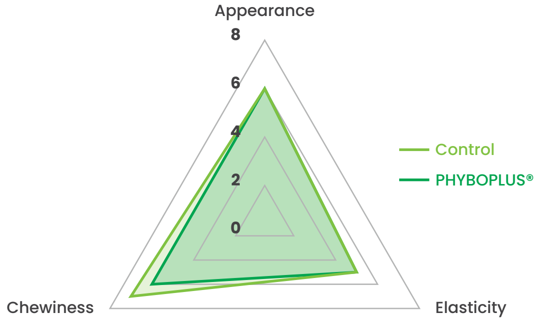

Figure 7. Sensory evaluation 9-point hedonic scale of jelly stick

By incorporating PHYBOPLUS® Series starch fiber into a wide range of products, from processed meats and desserts to baby food, soups, and sauces, manufacturers can significantly enhance their nutritional value. This strategic supplementation not only boosts health benefits but also elevates the market appeal of these products. Embrace the transformative potential of PHYBOPLUS® Series to create delicious, health-forward offerings that meet the growing consumer demand for nutritious and wholesome foods. Elevate your product portfolio and captivate health-conscious consumers with the unparalleled benefits of PHYBOPLUS® Series starch fiber.

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ABOUT SMS

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