American Journal of Biochemistry and Biotechnology 10 (2): 99-104, 2014
ISSN: 1553-3468

doi:10.3844/ajbbsp.2014.99.104 Published Online 10 (2) 2014 (http://www.thescipub.com/ajbb.toc)

THE EFFECT OF PRO-AND PREBIOTICS ON THE RHEOLOGICAL PROPERTIES OF THE MODEL OF STRUCTURED DISPERSE SYSTEMS

Natalia Aleksandrovna Tarasenko and Irina Borisovna Krasina

FGBOU VPO "Kuban State Technological University", Moskovskaya Street 2, Krasnodar, 350072, Russia

Received 2014-04-28; Revised 2014-06-08; Accepted 2014-07-02

ABSTRACT

The aim of this work is to carry out comprehensive studies that would allow to justify theoretically and experimentally use of probiotic poly-specific concentrates Bifilact A and Bifilact D and bifidogenic fiber intake Beneo^{TM}Synergy1 as high-performance synbiotic supplements. The selection of bifidogenic fibers for administration into uniform synbiotic systems is substantiated. Indicators of synbiotic systems consisting of Bifilact A or Bifilact D probiotics and Beneo^{TM}Synergy1 prebiotic are studied; at the same time the number of living cells of microorganisms in the system and the antagonistic activity of synbiotic systems was determined. The reasonability and efficacy of Beneo^{TM}Synergy1 fiber intake as a functional ingredient with bifidogenic properties was determined. The effect of the Beneo^{TM}Synergy1 prebiotic on the growth rate of lactobacilli and bifidobacteria is studied, which are the part of combined bacterial concentrates Bifilact A and Bifilact D. It was revealed that in synbiotic systems, fiber intake Beneo^{TM}Synergy1 stimulates the growth of probiotics and also enhances the antagonistic activity of bacterial concentrates Bifilact A and D that confirms the reasonability of creating a synbiotic system, representing a combination of probiotics Bifilact A or Bifilact D and prebiotic bifidogenic fiber intake Beneo^{TM}Synergy1. Conducted studies have shown the reasonaibility of creating a synbiotic system representing a combination of probiotics Bifilact A and Bifilact D and prebiotic bifidogenic fiber intake Beneo^{TM}Synergy1, providing synergistic effects on physiological functions in the human body. Performed analysis of functional and technological properties of pro-and prebiotics made it possible to determine main areas of their application in creating functional food systems with predetermined target properties and structure.

Keywords: Probiotics, Prebiotics, Synbiotic System, Fiber Intake

1. INTRODUCTION

Now the change in qualitative composition of the intestinal microflora is wide-spread, it is associated with the reduction of the immune status, metabolic disorders (Pool-Zobel and Sauer, 2007). This problem is often associated with the use of antibiotics that suppress the normal intestinal microflora and promote the appearance of highly resistant strains of pathogenic and opportunistic pathogen microorganisms (Bayskhanova and Omar, 2012).

Along with the use of antibiotics, the products containing probiotics and prebiotics are also widely used since they have a beneficial effect on the qualitative composition of the human's microflora through its correction, restoring digestive functions, as well as increasing the body's resistance against different infections (Winkler *et al*., 2005).

Over the recent times in the Russian Federation the range of fermented foods with probiotic cultures is constantly extending that is justified by their positive effects on human health (Dzhahimova *et al*., 2013).

Corresponding Author: Natalia Aleksandrovna Tarasenko, FGBOU VPO "Kuban State Technological University", Moskovskaya Street 2, Krasnodar, 350072, Russia

Table 1. Comparative evaluation of the probioyics and prebiotics effect

	Probiotics	Prebiotics
Functions	For introducing foreign microflora into the intestinal tract.	To stimulate the growth of own microflora.
Composition	Probiotic preparations containing living cells of normal intestine flora: Bifidobacteria, lactobacilli and others.	Prebiotics preparations contain substances that are nutraceuticals (food) for useful intestinal microflora.
Treatment strategy	Colonize the intestinal tract by foreign microflora.	Stimulate the growth of own intestinal microflora.
Permeability	Only 5-10% of living bacteria, contained in the probiotics, reach the colon.	Prebiotics are not digested in the upper gastrointestinal tract and reach the colon unaltered.
Selectivity	Probiotic preparations contain only 1-2 strains of beneficial bacteria out of the 500 species of the intestine normal flora.	Prebiotics, as food substrate for normal flora of the intestine, stimulate the entire population of beneficial bacteria.

Consumption of probiotics, i.e., the drugs and products created on the basis of living organisms from the representatives of the normal microflora of human and animals, is an important element of the healthy food concept that is one of the most effective and physiological ways to prevent disorders of the microflora in the gastrointestinal tract and thereby to treat a number of developing secondary disorders of not only digestive, but also the immune and endocrine systems (Vilshanskaya, 1979).

Prebiotics do not contain live microorganisms but they create flawless conditions for the existence and development of beneficial bacteria. Many prebiotics are the food for bacteria.

Prebiotics mainly include the variety of fiber intake that can be dissolved in water and food liquids (Yazawa and Tamura, 1978). Like other fiber intake, prebiotics have the ability to bind and excrete a portion of toxic substances coming along with food, including mutagenic pyrolysates formed from frying meat products at a high temperature. Prebiotics protect the intestinal tract against the penetration of pathogenic microorganisms (Anisimov, 2005), because they create an acidic environment unfavorable for enteric pathogens (Lodygin *et al*., 2006).

Differences in effect of probiotics and prebiotics are shown in **Table 1**.

2. MATERIALS AND METHODS

Viscosity of probiotics was determined by rheological method at 20°C using an Ostwald viscometer; specific growth rate of microorganisms was determined by increasing of biomass; quantitative account of microorganisms was performed by limiting dilution in Gas Modified Atmosphere (GMA) or Hydrozit of Maleic Acid (HMA) according to technical conditions TU 10-02-02-789-192-95; pH was measured by potentiometric method according to SSS 3624-87; antimutagenic activity was determined by Ames test; structural and mechanical properties of model systems were measured by reotest and CT-1 structure meter.

Experiments were performed in replicates of five times, providing reliable results and mathematical treatment of the results of experiments was performed using Statistica 6.0 package in accordance with the recommendations (Vosnesenskiy, 1981).

3. RESULTS

At the first stage we studied the indicators of synbiotic systems, consisting of Bifilact A or Bifilact D probiotics and Beneo^{TM}Synergy1 prebiotic. So we determined the number of living cellsof the microorganisms in the system after 6, 24, 36 and 48 h, as well as antagonistic activity of synbiotic systems was determined, wherein the Beneo^{TM}Synergy1 prebiotic was introduced into cultivation medium in an amount of 5%.

Results on the effect of the Beneo^{TM}Synergy1 prebiotic on growth rate of lactobacilli and bifidobacteria, which are the part of the combined bacterial concentrates Bifilact A and Bifilact D, are shown in **Fig. 1**.

The presented data show that the addition of Beneo^{TM}Synergy1 soluble fiber intake into the bouillon stimulates the growth of bifidobacteria and lactobacilli. So the biomass of probiotic cultures increases in 5-6 times.

It is interesting to note the increase of duration of the exponential growth phase on the medium supplemented by Beneo^{TM}Synergy1 prebiotic. This can be explained by the differences in the carbohydrate composition of the experimental media and the control media, as well as the inclusion of different enzyme groups into the metabolic process.

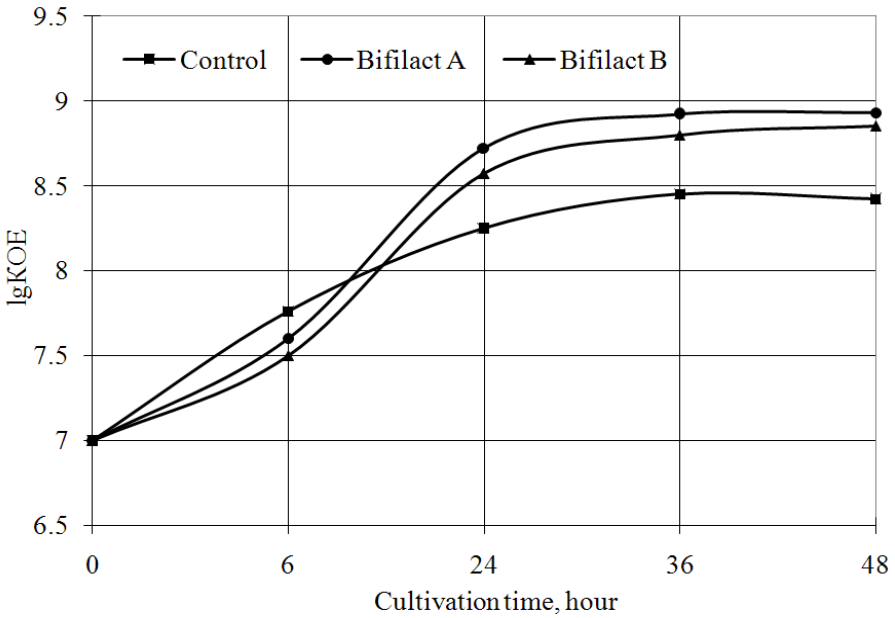

Fig. 1. Effect of fiber intake BeneoTMSynergy1 on probiotics growth rate

When studying the antagonistic activity, the growth suppressing of the test culture was observed as early as after 20 h of cultivation, whereas the complete destruction of the test cultures both of Bifilact A and Bifilact D was observed after 48 h. Investigation results of antagonistic activity of probiotics in symbiotic products with bifidogenic fiber are presented in **Fig. 2**.

As can be seen from the presented data, the significant antagonistic activity was shown by synbiotic systems and the introduction of bifidogenic fiber intake Beneo^{TM}Synergy1 promotes significant increase in antagonistic action of combined probiotic bacterial concentrates of Bifilact A and Bifilact D. Thus, under the influence of just bacterial concentrates, the number of E.coli cells decreased in 7.8 and 7.5 times, respectively, whereas under the action of synbiotic systems these figures were in 43 and 42.7. The growth suppression index of Pr. vulgaris for a system containing Bifilact D was 46.8±0,1%, whereas that for a system containing Bifilact A was 48,0±0,1%. The cell quantaty of Staph. aureus under the effect of Bifilact D bacterial concentrates in symbiotic with Beneo^{TM}Synergy1 decreased by 53±1%, while for concentrates of Bifilact A this figure was 55±1%. The inhibition degree of Citr. freundii when adding the symbiotic system to the test culture also increased.

To determine the technological properties of probiotics and prebiotics (Schrezenmeir and De Vrese, 2001) in structured dispersion systems, the studies were conducted on a model suspension of the powdered sugar particles, dispersed in confectionery fat at the dispersed phase concentration of 60%.

With the help of such suspension we can make a model of a simple two-component structured dispersion system with solid particles of the dispersed hydrophilic phase (sugar powder) and hydrophobic dispersion medium (confectionery fat). The structure formation process in fat mass is due to cohesion of sugar microparticles through the thin layers of the fat phase.

We have conducted studies on the effect of Bifilact A and Bifilact D probiotics, as well as Beneo^{TM}Synergy1 prebiotic, on the rheological properties of the "confectionary fat - sugar" model system. The amount of prebiotics introduced into the system varied from 1 to 20%, while the amount of probiotics ranged from 0.1 to 1% relative to the weight of the system components.

The research results concerning the effect of probiotics and prebiotics on the effective viscosity of model structured systems with undistorted and totally distorted structure is shown in **Fig. 3**. Data are given at a temperature of 28±1°C, the prebiotic dosage of 15% and the probiotic dosage of 0.8%.

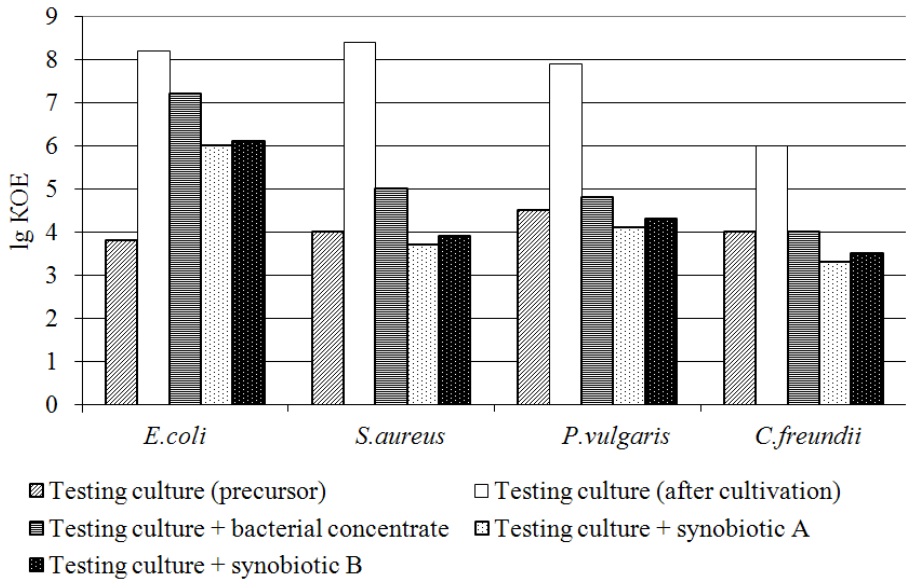

Fig. 2. The antagonistic activity of combined bacterial concentrates in the synbiotic products with bifidogenic fiber

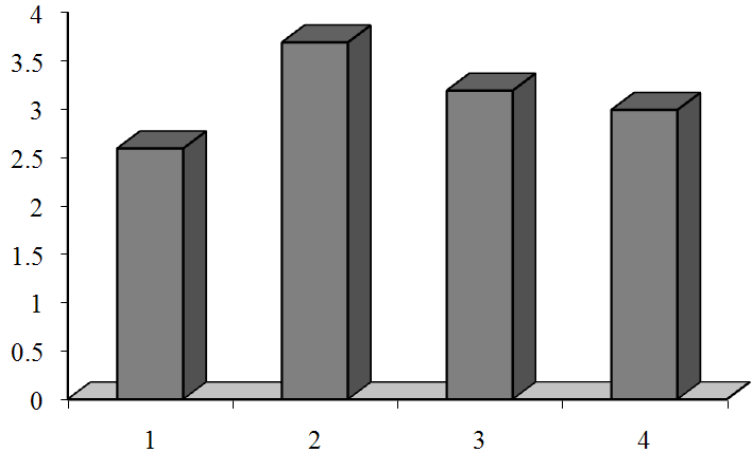

Fig. 3. Effect of probiotics and prebiotics on the change of the effective viscosity of the model systems with undistorted structure at a shear rate of 1 s^{-1}: 1-confectionary fat-sugar; 2-confectionery fat-sugar-BeneoTMSynergy1 prebiotic fiber; 3-confectionary fat-sugar-Bifilact D; 4-confectionery fat-sugar-Bifilact A

4. DISCUSSION

The main production technology of functional synbiotic products (Krasina *et al*., 2008) is a search andimplementation of natural origin substances, having both technological and physiological functionality (Shimizu *et al*., 2009).

It was experimentally revealed (Dzhahimova, 2009) that antagonism of bifidobacteria enhances in the presence of Beneo^{TM}Synergy1 prebiotic.

Thus, performed studies have shown the reasonability of creating a synbiotic system, representing a combination of Bifilact A or Bifilact D probiotics and the prebiotic, i.e., BeneoTMSynergy1 bifidogenic fiber intake, providing synergistic effect on physiological functions in the human body.

It should be noted that in structured disperse systems, the substances included in the probiotics and prebiotics (Mizota, 1996) can weaken the interaction between the particles of the solid phase by modifying the nature of

the surface of these particles due to adsorption at interfaces and the changing of nature of the bulk phase by equalizing the difference between their polarities that was confirmed by our research.

The presented data show that the introduction of probiotics and prebiotics into the model systems essentially increases the degree of the structure formation compared to that in the control sample without such introduction. This is likely in our opinion is due to the fact that the introduction of probiotics and prebiotics increases the concentration of solid phase in a liquid mediumthat is alsoconfirmed by the studies of other scientists (Becker and Lowe, 2003) and also correspondingly increases the active interphase surface that leads to the increase in molecular cohesion forces between the particles. This suggestion constenents with the data of Finkelman (1990), so the introduction of probiotics and prebiotics into the fatty stuffing (Krasina *et al*., 2009) allows one to control the strength of the contacts between the particles by changing their surface that makes it possible to recommend the investigated probiotics and prebiotics for effective control of technology processes for obtaining structured disperse systems.

It should be noted that the effect of Beneo^{TM}Synergy1 prebiotic fiber on the rheological properties of the model system is most pronounced in comparison with the effect of Bifilact A and Bifilact D probiotic cultures.

5. CONCLUSION

Studies have shown that Bifilact A and Bifilact D probiotics, as well as the Beneo^{TM}Synergy1 prebiotic fiber are effective supplements, which allow the change purposefully of the rheological properties of structured disperse systems.

Performed complex of analysis of functional and technological properties of probiotics and prebiotics made it possible to determine the main areas of their practical use in production of functional food systems with predetermined target properties and structure.

Unfortunately, the conducted studies of the use of probiotic polyspecific concentrates of Bifilact A and Bifilact D, as well as Beneo^{TM}Synergy1 bifidogenic fibe intaker have shown that their use as highly synbiotic supplements is possible only for fat fillings, not cooked. In the future it is necessary to develop a method for introduction of synbiotic supplements into confectionary products.

6. ACKNOWLEDGMENT

The research was performed under the grant of the President of the Russian Federation for state support of young Russian PhD scientists (MK -1133.2014.4) as part of the topic «Development of innovative technologies and formulations of functional confectionery products using sinbiotics».

7. REFERENCES

Anisimov, S.V., 2005. New prebiotic products of the healthy nutrition line. Dairy industry, 4: 55.

Bayskhanova, D.M. and R.T. Omarov, 2012. Bioactive products based on probiotic cultures and plant extracts. Biotechnology. Theory Pract., 2: 27-34.

Becker, D.J. and J.B. Lowe, 2003. Fucose: Biosynthesis and biological function in mammals.

Dzhahimova, O.I., 2009. Technology improving of functional wafers with symbiotic properties. PhD Theses, 'Kuban State Technological University, Krasnodar.

Dzhahimova, O.I., I.B. Krasin and N.A. Tarasenko, 2013. Application of functional supplements in the manufacture of pastry products. News of higher educational institutions. Food Technol., 1: 40-42.

Finkelman, M.A.J., 1990. Yeast strain development for extracellular enzyme production. Bioprocess Technol., 8: 185-223.

Krasina, I.B., O.I. Dzhahimova, N.A. Tarasenko and N.A. Zubco, 2009. Role of dietary fiber when generating wafers quality. News of higher educational institutions. Food technology, 4: 44-45.

Krasina, I.B., O.I. Dzhahimova, N.A. Tarasenko, A.V. Demidov and O.N. Arakcheeva, 2008. Wafers with functional properties. News of higher educational institutions. Food Technol., 1: 41-42.

Lodygin, A.D., I.A. Evdokimov and S.A. Riabtseva, 2006. Concentrates with prebiotic properties based on the milk whey. Dairy industry, 6: 69-70.

Mizota, T., 1996. Functional and Nutritional foods Containing Bifidogenic Factor. 1st Edn., Bull International Dairy Federation, pp: 313.

Pool-Zobel, B.L. and J. Sauer, 2007. Overview of experimental data on reduction of colorectal cancer risk by inulin-type fructans. J. Nutrit., 137: 2580-2584. PMID: 17951507

Schrezenmeir, J. and M. De Vrese, 2001. Probiotics, prebiotics and synbiotics-approaching a definition. Am. Society Clin. Nutr., 73: 361-364.

Shimizu, K., H. Ogura and M. Goto, 2009. Synbiotics decrease the incidence of septic complications in patients with severe SIRS: A preliminary report. Dig. Dis. Sci., 54: 1071-1078. DOI: 10.1007/s10620-008-0460-2

Vilshanskaya, F.L., 1979. Characteristics of microflora in intestinal dysbacteriosis: pathological significance of dysbacteriosis in intestinal disorders and efficacy of Colibacterin application for therapeutic purposes. PhD theses, Academy of Medical Sciences, Moscow.

Vosnesenskiy, V.A., 1981. Statistical Methods of Experiment Planning in Techno-Economic Studies. 1st Edn., Finance and Statistics, Moscow, pp: 99.

Winkler, P., M. de Vrese, C. Laue and J. Schrezenmeir, 2005. Effect of a dietary supplement containing probiotic bacteria plus vitamins and minerals on common cold infections and cellular immune parameters. Int. J. Clin. Pharmacol., Therapy Toxicol., 43: 318-326. DOI: 10.5414/CPP43318

Yazawa, K.K. and Z. Tamura, 1978. Oligosaccharides and polysaccharides specifically utilizable by bifidobacteria. Chem. Pharmaceutical Bull., 26: 3306-3311. DOI: 10.1248/cpb.26.3306