CONCENTRATION OF SHORT-CHAIN AND BRANCHED FATTY ACIDS IN THE FAECES OF CHILDREN CONSUMING A PREPARATION WITH PREBIOTIC RESISTANT DEXTRIN

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Abstract - The aim of thesis this was to determine the effect of prebiotic resistant dextrin on the concentration of short-chain fatty acids (SCFA) and branched-chain fatty acids (BCFA). The scope of this work included determination of the type and concentration of fatty acids such as: formic, acetic, propionic, butyric, valeric, isobutyric, isovaleric and lactic acid in the feces of obese children. Children were taking for 6 months prebiotic in the form of vegetable-fruit preserve containing resistant dextrin. Samples of their faeces were collected before prebiotic intake and after 6 months of a prebiotic consumption. Based on the obtained results, it was stated that resistant dextrin had a positive effect on the growth of the concentration of lactic acid and of the SCFA and negatively influenced of the concentration of the BCFA. The highest increase in the concentration has been observed for lactic acid and the smallest one for butyric acid.

Keywords - Resistant Dextrin, SCFA, BCFA

I. INTRODUCTION

Microbiome is an integral part of human organism and even slight aberrations in its quantity, composition, and metabolic processes, called dysbiosis, can lead to various health problems. In the human body, the usual composition of normal gut microbiota is following: Bacteroides, Actinomycetes, Firmicutes, Proteus, and Fusobacteria. Apart from the particular composition of healthy gut microbiota, its diversity is also an essential factor. Lack of its diversity is very often a cause of diseases such as obesity [Bing-Nan et al., 2021]. Nevertheless, microbiota residing gastrointestinal tract is not uncontrolled and its amount and composition can be regulated to significant extent by different external factors. While there exist some endogenous factors affecting microbial balance, for instance secretion of mucin and formation of mucus barrier, some exogenous factors such as food ingredients that we intake and provide microbiota with, serve as the main energy source for their development. Apart from affecting their growth, there also exist substances, in particular non-digestible carbohydrates, which can regulate the function and composition of gut microbiota [Davani-Davari et al., 2019].
Prebiotics are nutrients that are used as a fermentation substrate for gut microflora and their degradation products are short-chain fatty acids which then enter the blood circulation and affect gastrointestinal tracts and other organs, and systems. They also possess a wide variety of advantages over antibiotics which have negative effect on beneficial intestinal microflora, used too frequently can lead to the formation of antimicrobial resistance genes and may cause allergies. Despite high accessibility of the natural food ingredients serving as prebiotics, they are present in the nature in small quantities [Markowiak-Kopeć and Śliżewska, 2020].

Due to the increased interest in the chemical synthesis of the prebiotics on the higher scale and its constant improvement, more attention has been paid to the resistant dextrin deriving from the starch which prebiotic properties are long since wellknown [BeMiller, 2003]. These distinctions opened the area of the research of possible improved or additional beneficial effects of resistant dextrin as a prebiotic on the human's health and its application in alimentary products.

The objective of this thesis was to determine the effect of prebiotic resistant dextrin on the concentration of short-chain fatty acids (SCFA) and branched-chain fatty acids (BCFA).

II. MATERIAL AND METHODS

The examined samples consisted of the faeces of the overweight and obese children in the age range: 7-10 years, who were patients of the Children's Memorial Health Institute in Warsaw. Children were taking for 6 months prebiotic in the form of vegetable-fruit preserve containing prebiotic resistant dextrin. Samples of their faeces were collected before prebiotic intake and after 6 months of a prebiotic consumption.

These were experimental samples. Control samples consisted of the samples of the faeces of the children who were also intaking vegetable and fruit preserve; however, without resistant dextrin. Faeces samples

were collected before and after 6 months of the intake of the preserve.

There was measured 0,5 g of faeces and put into the 7 ml falcon. Then 3 ml of sterile demineralised water was added. Each sample was placed on the vortex mixer for 5 minutes and after that centrifuged (Centrifuge MP-251) for 20 minutes in 14 000 RPM. The supernatant was collected and filtrated with syringe filter of the 0,22 µm membrane pore size. Then at least 1 ml of filtrated supernatant was collected for further HPLC analysis.

Detection and determination of the concentration of lactic acid; short chain fatty acids (formic, acetic, propionic, butyric, valeric), branched-chain fatty acids (isobutyric, isovaleric) was performed using high-performance liquid chromatograph Surveyor (Thermo Scientific, USA). All the necessary parameters of the apparatus that were set during HPLC analysis are placed in the table 1.

Parameters	Value
Temperature of the analysis	60°C
Time of the analysis of each sample	35 min
Sample injection	10 µl
Flow rate	0,6 µl/min
Column	Aminex HPX 87H+ (300 mm x 7,8 mm)
Packing material in column	Sulfonated styrene-divinylbenzene copolymer
Moving phase	0,005M H_2SO_4
Detector	UV light at the wavelength 210 nm
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Autosampler	Loop with a syringe

Table 1. Parameters for the analysis performed by HPLC method

III. RESULTS AND DISCUSSION

The values of the examined SCFAs, BFAs and lactic acid concentrations from the faeces were gathered in the tables. In the table 2 there are presented concentrations [mg of fatty acid/g of faeces] of analysed fatty acids before intake of prebiotic resistant dextrin and vegetable-fruit preserve without prebiotic resistant dextrin, whereas in the table 3 there are gathered concentrations [mg of fatty acid / g of faeces] of examined fatty acids after 6 months of the consumption of prebiotic and vegetable-fruit preserve without resistant dextrin.

Before intake								
No.	Lactic	Formic	Acetic	Propionic	Isobutyric	Butyric	Isovaleric	Valeric
Experimental samples								
1	0.672	4,230	3.944	2.730	1.965	3.412	0.529	2.116
2	0.774	2.397	2.649	1.184	4.537	0.771	0.366	1.060
3	0.296	0.774	1.518	0.641	0.196	0.331	0.463	2.510
4	0.649	2.726	2.707	1.424	0.555	1.050	0.724	0.342
5	0.652	1.463	3.128	0.852	0.746	0.655	0.584	0.000
Average	0.609	2.318	2.789	1.366	1.600	1.244	0.533	1.205
Control samples								
1	2.755	3.297	2.302	0.782	0.075	1.078	0.410	1.102
2	2.682	1.535	4.027	1.443	1.652	1.374	0.640	0.230
3	3.214	0.986	4.253	3.382	0.191	1.178	0.610	3.834
4	1.671	4.675	4.942	1.877	2.413	1.158	0.596	2.525
5	0.814	3.059	3.283	2.185	0.286	2.899	1.128	0.000
Average	2.227	2.710	3.762	1.934	0.923	1.537	0.677	1.538

Table 6. Concentrations of SCFAs, BFAs and lactic acid before intake of the prebiotic resistant dextrin (experimental samples) and vegetable-fruit preserves without prebiotic resistant dextrin (control samples)

After 6 months intake

No.	Lactic	Formic	Acetic	Propionic	Isobutyric	Butyric	Isovaleric	Valeric
Experimental samples								
1	1.043	11.717	4.290	2.096	1.408	2.051	0.147	2.143
2	4.746	5.278	10.46	3.822	0.701	1.503	0.574	5.352
3	3.821	3.807	2.424	1.364	0.874	1.443	0.003	0.364
4	1.704	3.818	3.257	4.276	0.959	2.219	0.244	1.130
5	1.315	3.962	2.171	2.800	0.947	1.626	0.578	0.351
Average	2.526	5.716	4.522	2.872	0.978	1.768	0.309	1.868
Control samples								
1	1.726	4.115	3.662	1.628	0.733	1.208	0.289	1.722
2	0.239	2.763	3.618	1.283	1.004	1.570	0.812	0.913
3	0.239	2.763	3.618	1.283	1.004	1.570	0.812	0.913
4	4.632	3.253	3.938	3.670	1.029	1.938	0.236	1.140
5	0.672	5.578	5.143	1.174	1.351	1.295	0.308	2.057
Average	1.803	3.559	3.974	2.023	0.973	1.427	0.329	1.308

Table 7. Concentrations of SCFAs, BFAs and lactic acid after 6 months intake of the prebiotic resistant dextrin (experimental samples) and vegetable-fruit preserves without prebiotic resistant dextrin (control samples)

Comparing all values of the concentrations of SCFAs, BFAs and lactic acid before prebiotic intake and after 6 months of the consumption of prebiotic containing resistant dextrin, there can be noticed the growing concentration tendency for SCFAs and lactic acid (Figure 1). Whereas a decreasing concentration tendency for BCFAs has been observed. Among all examined fatty acids, the highest difference between the concentration before and after prebiotic intake has been observed for lactic acid which is not classified neither as a SCFA nor as a BCFA. Its concentration has increased almost 4 times, from 0.609 mg of lactic acid / g of faeces to 2.526 mg of lactic acid / g of faeces after 6 months of prebiotic consumption. On the other hand, the smallest difference has been observed for butyric acid which has increased only 1.4 times from 1.244 mg of butyric acid/g of faeces to 1.769 mg of butyric acid/g of faeces after 6 months of prebiotic intake. In general, the growing concentration tendency has been noted for: lactic acid, formic acid, acetic acid, propionic acid, butyric acid and valeric acid. Whereas a decreasing concentration tendency has been observed for isobutyric and isovaleric acids.

All these differences can be explained by shifts of balance in the gut microbiota or changes in its diversity caused by unhealthy (or gender-influenced) diet or associated with occurrence of obesity, which can have a major impact on the secretion of active com-pounds such as lactic acid, SCFAs, BCFAs and the activity of fecal enzymes [Gomeset. al., 2020].

Fatty acids are produced in the large intestine as byproducts of fermentation of die-tary fibers and resistant starches by several species of bacteria residing in this environ-ment. As mentioned before, SCFAs have many confirmed positive effects on the human body, while BCFAs are rather associated with negative impact [Frampton et al., 2020;Peredo-Lovilloet al., 2020].

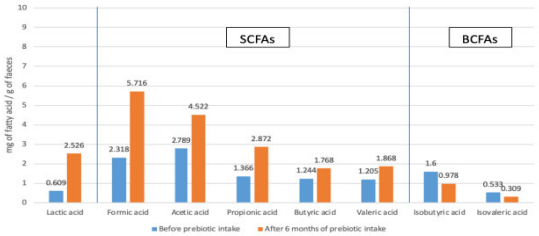


Figure 1. Comparison of the concentrations of SCFAs, BFAs and lactic acid before and after 6 months of the prebiotic resistant dextrin intake.

IV. CONCLUSION

Magnitude of the change of the concentration of short-chain fatty acids (SCFAs) and branched-chain fatty acids (BCFAs) influenced by resistant dextrin, depended on the type of examined fatty acid and individual differences between examined children (such as e.g., diet and external factors).Prebiotic resistant dextrin had a positive effect on the growth of the concentration of lactic acid and of the SCFA and negatively influenced of the concentration of the BCFA.The highest increase in the concentration, after 6 months of resistant dextrin prebiotic intake, has been observed for lactic acid and the smallest one for butyric acid.

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