

SOLUBLE CORN FIBERS

IN VITRO FERMENTATION CHARACTERISTICS OF CORN ARABINOXYLAN: EFFECT ON GUT MICROBIOTA AND SHORT CHAINS FATTY ACIDS PRODUCTION

OVERVIEW

Owing to their chemical structure, dietary fibers are classified among carbohydrates that cannot be digested or absorbed in the small intestine^[1]. Dietary fibers can be subdivided into soluble dietary fiber and insoluble dietary fiber. Soluble dietary fibers include inulin, arabinoxylan, psyllium, and glucan, while insoluble dietary fibers consist mainly of lignin and cellulose. Decades of research point to the health benefits of soluble dietary fibers such as lowering blood glucose response and plasma cholesterol levels, favoring beneficial gut microflora and improving general host health through their prebiotic effects^{[2] [3]}. Epidemiologic studies have also consistently associated soluble dietary fibers with reduced risk of developing cardiovascular disease, type II diabetes, and gastrointestinal cancers^{[4] [5]}.

ClonBio's corn arabinoxylan is a new ingredient that can play a significant role in fiber enhancement strategies. Furthermore the associated health benefits can provide additional value in specialized applications. To review these benefits, preparations of the corn arabinoxylan were pre-digested and fermented in vitro to mimic its journey in the gastrointestinal tract.

New knowledge on how saturated short chain fatty acids (SCFAs) are converted in the gut is described here to provide a foundation for their use as a food functional ingredient. Corn arabinoxylan was found to promote the proliferation of specific gut microbiota that exhibit probiotic effects and increase the production of health relevant short chain fatty acids such as acetate, butyrate, and propionate.

EFFECT OF CORN ARABINOXYLAN ON GUT MICROBIOTA AND THE PRODUCTION OF SHORT CHAINS FATTY ACIDS

ClonBio's corn arabinoxylan (Corn AX; 200 kDa) was used in an in-vitro human fecal fermentation trial.

The study consisted of 16S metagenomic profiling and short chain fatty acid analysis of batch cultures containing a mixture of fecal samples from three different healthy donors (omnivorous; age range 36 – 47 years; no recent history of antibiotic, probiotics or prebiotic intake). The fiber was pre-digested using the INFOGEST in-vitro digestion model ^[6] followed by in vitro fermentation.

A sample (3 mL) was taken at baseline of the fecal inoculum (T0). Three milliliter samples of each batch culture were taken after 6 hours (T6), 12 hours (T12), 18 hours (T18) and 24 hours (T24) for high-throughput sequencing and short chain fatty acid analysis.

MICROBIOTA COMPOSITION

Figure 1 illustrates the taxonomic profiling of the predominant fecal bacteria (n=21). Particularly, *Faecalibacterium*, *Akkermansia*, *Lachnospiraceae*, and *Oscillospira* were found the most abundant bacteria in the human gut microbiota, suggesting that these organisms are likely to play an important role in human health.

Corn arabinoxylan promotes the growth of *Faecalibacterium prausnitzii*, *Lachnospiraceae*, and *Oscillospira*.

Following incubation, Corn AX increased *Faecalibacterium prausnitzii* above the inoculum level after 18h. *Faecalibacterium prausnitzii* plays a crucial role in maintaining local and systemic host health. They are often found to be less abundant in individuals affected by colorectal cancer ^[7] and certain forms of inflammatory disorders (e.g., alternating-type irritable bowel syndrome (IBS), inflammatory bowel diseases, and celiac disease). This is also observed in individuals suffering from type 2 diabetes, appendicitis, chronic diarrhea ^{[8][9]} and obesity. *Faecalibacterium prausnitzii*, is also the main producer of butyrate in the colon ^{[10][11]}.

Lachnospiraceae were found abundant into Corn AX cultures. *Lachnospiraceae* degrade complex polysaccharides into short-chain fatty acids, including acetate, butyrate, and propionate, that can subsequently be used for energy by the host ^[12]. In adults, this family of probiotic have been associated with protection against *C. difficile* infections, cancer and obesity^[13]. *Oscillospira* population was also increased when in the presence of Corn AX.

Oscillospira can produce a large variety of short-chain fatty acids (SCFAs) including significant levels of butyrate^[14]. *Oscillospira* is known to have a positive impact in some specific diseases, such as obesity-related metabolic diseases. It has already been established as a next generation probiotic candidate and has potential application in specialized future foods.

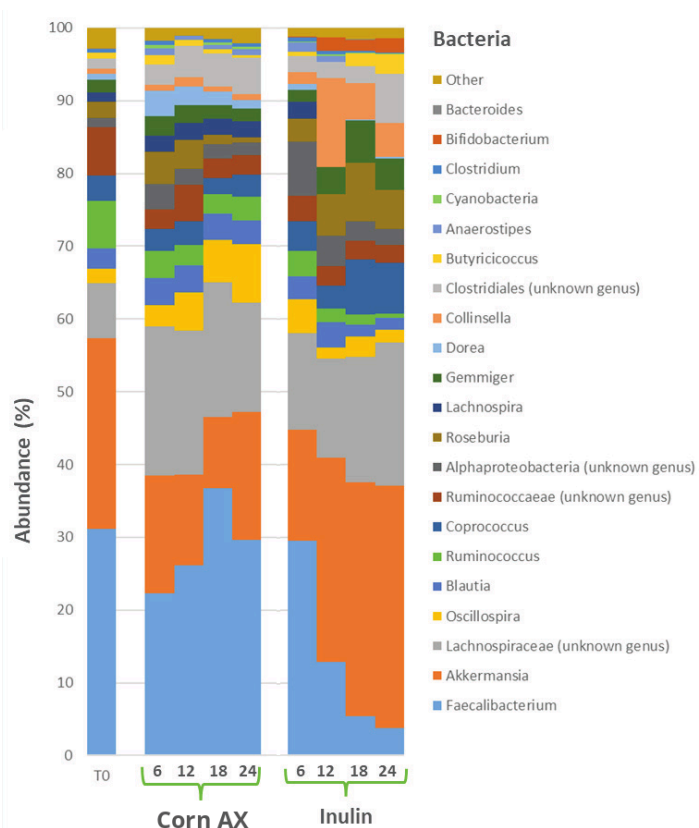


Figure 1: Taxonomic analysis to Genus's level using the 21 most predominant organisms (relative abundance).

SHORT CHAIN FATTY ACIDS COMPOSITION

		Acetic acid	Isobutyric acid	Butyric acid	Isovaleric acid	Caproic acid	Methylhexanoic acid	Caprylic acid	Lactic acid	Propionic acid	Total
Corn AX	0	19	0.55	13.84	5.38	20.26	11.25	48.11	0	0	118.39
	6h	359.64	4.14	236.51	19.23	22.35	11.06	63.03	0	12.23	728.19
	12h	369.02	7.57	225.76	32.45	14.98	6.48	37.51	5.79	13.87	713.43
	18h	451.73	12.11	296.26	46.16	13.27	5.99	29.91	0	13.46	868.89
	24h	419.57	10.65	271.54	40.56	13.28	5.64	29.67	0	11.93	802.84
Inulin	0	19	0.55	13.84	5.38	20.26	11.25	48.11	0	0	118.39
	6h	320.59	34.31	78.32	5.21	14	8.22	30.22	0	13.14	504.01
	12h	235.59	18.48	37	3.2	13.01	7.15	25.65	11.1	10.87	362.05
	18h	152.37	17.51	70.04	5.04	10.37	7.76	21.2	8.23	10.49	303.01
	24h	124.88	16.94	80.9	6.16	0	0	20.07	0	11.23	260.18

Table 1: Short chain fatty acids profile (expressed in µg/ml)

Table 1 illustrates how corn arabinoxylan promotes the production of SCFAs. Corn AX increased the total amount of SCFAs sharply within the first 6 hours and sustained it through to 24 hours, peaking at 18 hours, while inulin peaked at 6 hours and declined thereafter. SCFAs serve critical functions both as energy sources and regulators of inflammation, cell proliferation, and apoptosis [15]. These observations show that the structure of the corn arabinoxylan, at the stage of reaching the distal part of the gastrointestinal tract, plays a central role in shaping the taxonomy and metabolic output of the human gut microbiota and, in turn, the overall health status of the host [16].

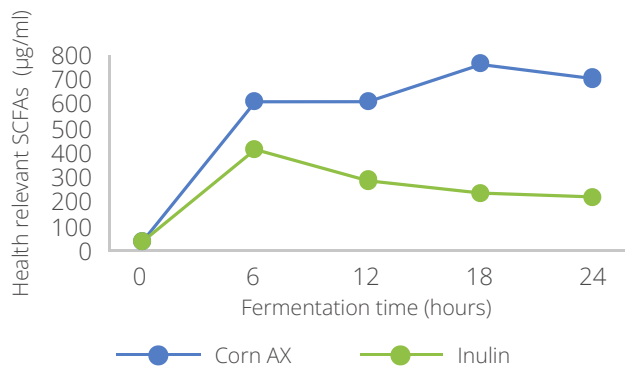


Figure 2: Health relevant SCFAs (acetate, butyrate, and propionate).

Corn arabinoxylan selectively promotes the growth of beneficial gut microbes such as lactic acid bacteria.

Corn arabinoxylan increased the production of health relevant SCFAs (acetate, propionate, and butyrate) compared with the baseline and with inulin (Figure 2). The most abundant SCFA acetate is known to have several health benefits related to energy production and synthesis of lipids. Propionate is mainly involved in producing glucose in the liver and small intestine and it has been linked to beneficial immunological and metabolic effects. Butyrate has been shown to be important for the prevention of inflammation, by inducing differentiation of regulatory T cells and down-regulating the expression of genes encoding proinflammatory cytokines [17].

Corn arabinoxylan increased the production of health relevant SCFAs (acetate, propionate, and butyrate).

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