The 12th Vahouny Fiber Symposium

Abstracts – Invited Presentations

Session 1: Substantiating human physiological benefits for isolated and synthetic nondigestible carbohydrates

Forty Years Featuring Fiber
David M. Klurfeld, USDA Agricultural Research Service, Beltsville, MD

The first Spring Symposium on Dietary Fiber in Health and Disease held in Washington, D.C. in 1981 was organized by George Vahouny and David Kritchevsky. Out of this grew a series of international symposia on recent developments in dietary fiber research that was named for George Vahouny following his death in 1986 at the age of 54. Subsequent fiber meetings every few years were organized primarily by David Kritchevsky, Charles Bonfield, James Anderson, and Susan Cho. The purpose of these meetings was to highlight new research, both directly and indirectly relevant to the field of dietary fiber, to stimulate free exchange of ideas, and to achieve these in a friendly environment. Many of the important questions related to dietary fiber remain unanswered today with fewer labs focused on them, including physiologic effects, mechanisms by which fiber has those influences, and its role in shaping the gut microbiota and secreted metabolites that affect host health and metabolism.

FDA Perspective: status of evidence to qualify as dietary fiber for food labeling
Sarah Gebauer and Fabiana Moura, US Food & Drug Administration

FDA issued a final rule in 2016 that updated the Nutrition and Supplement Facts labels and included a definition of dietary fiber. Previous requirements for declaration of dietary fiber did not define dietary fiber, but rather relied on analytical methods for measuring total, soluble, and insoluble fiber. The Nutrition Facts label final rule defines dietary fiber as: non-digestible soluble and insoluble carbohydrates (with 3 or more monomeric units) and lignin that are intrinsic and intact in plants; isolated or synthetic non-digestible carbohydrates (with 3 or more monomeric units) determined by FDA to have physiological effects that are beneficial to human health. The final rule identified seven isolated or synthetic non-digestible carbohydrates, in addition to intrinsic and intact fiber, as meeting the dietary fiber definition. In 2018, FDA issued a final guidance for industry on how FDA intends to evaluate the scientific evidence on the physiological effects of isolated or synthetic non-digestible carbohydrates. Since then, FDA has identified, through the issuance of guidance or responses to citizen petitions, 10 additional isolated or synthetic non-digestible carbohydrates that the agency intends to propose to be added to our regulatory definition of dietary fiber. The presentation will provide an overview of: 1) FDA's regulatory definition of dietary fiber; 2) the scientific review approach used for evaluating scientific evidence to determine whether an isolated or synthetic non-digestible carbohydrate has a physiological effect that is beneficial to human health.

Normal Gut Permeability
Michael Camilleri, Mayo Clinic

The objectives of this talk are to understand the components of the intestinal barrier and pores that result in increase in passage of molecules across the gastrointestinal epithelium. It is important to recognize that the barrier in the gastrointestinal tract consists of more than just the epithelial cells and the tight junctions in between those cells. Specifically, digestive enzymes in the lumen, commensal bacteria, mucus, as well as the immune apparatus and peristalsis enhance the barrier for passage of antigens and bacterial species from the intestinal lumen into the lamina propria. The second objective is to review in vivo measurements of intestinal permeability in humans. A third aim evaluates components in the diet that have been associated with increased barrier function or damage to barrier function.
Nutrients that fortify the intestinal barrier include fiber, glutamine, vitamin D, vitamin A, cysteine and tryptophan; whereas, nutrients that damage intestinal barrier include ethanol, bile acids, gliadin emulsifiers, and fat. In addition, examples will be provided on the effects of different types of fiber such as inulin, pectin, and fructo-oligosaccharide on barrier function in the healthy state, as well as data from the literature on studies performed with fiber in disease states such as nonalcoholic fatty liver disease, environmental enteropathy, obesity, and colitis.

Impact of dietary fibre chemistry on consumer immunity
Paul de Vos, University of Groningen, Netherlands

The gastrointestinal tract harbors approximately 80% of the human immune system. It is in continuous contact with the luminal content of the intestine and equipped with unique cell types to distinguish the good from the bad. The gut immune system has to be tolerant to the 100 trillion bacteria that support our metabolism and immunity. It must accept the bacteria as its own as we depend on the bacteria for production of enzymes that we need to digest food. At the same time, it should delete any pathogen or toxin that is in between the 100 trillion bacteria. During recent years we have learned how to support immunity in the intestine with specific food components. By applying new technologies and better analytical approaches to characterize dietary fibers, we are more than ever able to identify efficacious immune regulating carbohydrates or probiotics. In these efforts, we did a number of important observations for application. Not all carbohydrates have the same effects in different age classes and disorders. Efficacy totally depends either on the chemistry of the carbohydrates. We have shown that molecular length or degree of methyl acidification of for example the dietary fiber pectins determine efficacy in preventing pancreatitis or type 1 diabetes in animal models. Studies in humans in our own institute have shown that support of immunity can be achieved when carbohydrates are carefully selected and tested. Age-related decline of immunity can even be delayed by designing effective intervention strategies. Our data underscore the importance of chemistry of food components for immune effects and the need to select target groups to achieve optimal effects.

Prebiotics, gut microbiome, and health- Example of calcium metabolism and bone health
Connie Weaver, Purdue University and Weaver and Associates Consulting

Prebiotic fibers, such as galactooligosaccharides, inulin, and soluble corn fiber increase microbial fiber fermentation and production of short chain fatty acids, but the exact mechanisms are yet to be determined. Changes in specific gut bacteria with prebiotic feeding have been associated with increased calcium absorption. Increases in fractional calcium absorption in children and bone calcium retention in postmenopausal women with consumption of prebiotic fibers are functional health indicators that have been associated with greater bone mineral density. Improved calcium utilization is important as calcium intakes around the world fall below recommendations. Future research aimed at identifying responders to diet and identifying causal mechanisms is needed.

Session 3: Advancing Science: Applying Carbohydrate Knowledge

When and how to use a free database tool on fiber and health outcomes
Nicola McKeown, Tufts University

In 2013, Dr. Nicola McKeown and colleagues at Tufts University developed a publicly available fiber database, "The Diet-Related Fibers and Human Health Outcomes Database." This tool is updated annually and contains population, intervention, comparator, and outcome (PICO) data extracted from published human intervention studies. Dietary fiber research is ongoing as demonstrated by a 33% increase in publications from the first release of the database (containing data from 868 studies) to the most current version 5 (1,294 studies).The database is a rich resource aimed at assisting policy-makers and researchers, for example those who are reviewing the evidence on the physiological health effects of dietary fibers or those interested in a specific fiber type. The database is a tool that efficiently facilitates summaries of the literature on a specific topic and helps to identify gaps in the literature, thus directing new research. The objective of this presentation is to provide an overview of the database and to illustrate a practical application of its use.

Session 4: Standardized protocol (PICO) for evaluating digestive tolerance Of nondigestible carbohydrates among the general population

Considerations for Designing a Protocol to Evaluate Tolerance of Nondigestible Carbohydrates
Hannah Holscher, University of Illinois

Nondigestible carbohydrates (NDC) include dietary fiber and resistant starch, which are intrinsic and intact in plants and supplemented in foods. Consumption of certain NDC in adequate amounts has physiological effects that are beneficial to human health. However, the characteristics of the NDC and host factors will affect acceptability. Therefore, there is a need

for a standardized protocol for assessing tolerance of NDC. Development of a protocol for clinical studies on tolerance includes considering many factors, including trial design, the study population, the intervention and control products, and outcomes.

Nondigestible Carbohydrate Intervention and Control Product Considerations in GI Tolerance Tests
Wendy Dahl, University of Florida

The food product selected to evaluate digestive tolerance of a non-digestible carbohydrate is a key factor in the design of a clinical trial. Although dose of non-digestible carbohydrates is well known to affect tolerance, specifics of the food product formulation as well as the timing and frequency of administration are also important considerations, as is the choice of the food product comparator. Although the background diet, whether controlled feeding or habitual, is often reported with tolerance study findings, diet's potential to modulate microbiota composition and its activity, and thus possibly influence tolerance reporting requires exploration. This presentation will provide an overview of food product recommendations and dietary considerations for gastrointestinal tolerance testing.

Defining study populations for evaluating digestive tolerance of nondigestible carbohydrates
DeAnn Liska, Texas A&M

Selection of study population is an important factor in clinical studies on digestive tolerance of non-digestible carbohydrates. Gastrointestinal (GI) tolerance response is variable across and within individuals, and can be influenced by a number of factors including physical activity, background diet, and supplement, alcohol and drug use. In particular, it has been shown that for some fibers, some people react, while others do not. Determining the study population also depends on the intended purpose of the data, and whether extrapolation to the broader population is important or defining a specific endpoint, such as laxation threshold, is the goal. This talk will outline considerations for selection of population for trials, as well as approaches to help address variability, such as developing robust baseline data (e.g., via run-in) and through subpopulation analyses.

Subjective and objective outcome parameters for the assessment of GI tolerance
Krtistin Verbeke, KU Leuven, Belgium

Assessment of gastrointestinal tolerance to indigestible carbohydrates generally involves the evaluation of gastrointestinal symptoms and of stool habits. Both aspects can be measured with subjective parameters (questionnaires) or objective parameters (measured on collected samples). The specific research question determines the optimal outcome parameters. Studies that aim to assess the (detailed) response to a single dose of indigestible carbohydrates will

need different outcomes than studies that evaluate the response of long-term intake on a population level. This presentation will provide an overview of the available outcome parameters with their advantages and limitations.

Special Considerations for Gastrointestinal Tolerance Testing in Children
Bruno Chumpitazi, Baylor College of Medicine

There are more than 70 million children in the United States with the estimated worldwide childhood population reaching over 2 billion. There are several considerations for gastrointestinal tolerance testing in children including: the developmental age of the child, whether parental or caregiver assessments of the child's tolerance will be included, methods to determine a child's dietary intake, and physiologic differences (e.g., estimated dietary fiber needs, gut microbiome composition) in children vs. adults. Gastrointestinal tolerance testing in children may benefit from usage of age-based pediatric validated questionnaires assessing gastrointestinal symptoms of interest and pediatric validated stool form assessment measures. Non-invasive assessments of gut physiologic responses to fiber can be employed to assess intestinal transit time (carmine red, radioopaque markers, capsules), gastrointestinal permeability (sugar probes), intraluminal environment including pH/contractility (wireless capsule), gut microbiome composition via fecal testing, and gut immune activation (fecal proteins).

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Abstracts

Session 2: Innovation Briefs

Effect of chicory inulin-type fructan–containing snack bars on the human gut microbiota in low dietary fiber consumers in a randomized crossover trial

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Adding fiber to snack foods may help to meet dietary fiber intake recommendations and could alter the intestinal microbiota to a more favorable composition and function. We investigated whether the intake of low and moderate-dose fiber-containing snack bars has an effect on gut microbiota in healthy adults with a low dietary fiber intake. Two separate 4-wk, placebo-controlled, double-blind, crossover trials were conducted. Fifty healthy adults with low dietary fiber intake were randomly assigned to receive either moderate-dose fiber (7g/d) snack bars or an isocaloric control (Trial 1, n=25) or low dose fiber (3g/d) snack bars or an isocaloric control (Trial 2, n=25). The snack bars mainly comprised chicory root inulin-type fructans (ITF). Gut microbiota were analyzed using 16S ribosomal RNA-based approaches. The moderate-dose group showed significant differences across multiple microbial taxa compared with the control group, in particular an increased relative abundance of the Bifidobacterium genus from (mean±SEM) 5.3%±5.9% to 18.7±15.0%. Significant increases were also found in the low-dose ITF group, however, these disappeared after correction for multiple comparisons. In the low-dose group, targeted analysis with qPCR showed a significant increase in Bifidobacterium. Fecal SCFAs were affected by time but not treatment and there were no between-group differences in gastrointestinal symptoms. Notably, fiber intake increased significantly with both snack bars. Adding 3 or 7 g ITF to snack bars increased Bifidobacterium, which is a beneficial member of the gut microbiota. The addition of ITF to food products could help increase dietary fiber intake. This trial was registered at clinicaltrials.gov as NCT03042494. Am J Clin Nutr 2020;111(6):1286-96.

Dried Chicory Root as a Novel Way to increase Natural, Multiple Fiber intake

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Dietary fibers have long been considered in isolation, as single chemical compounds exerting specific physiological effects. One of the most prominent examples is native inulin, the prebiotic fiber known for its capacity to improve intestinal regularity and stimulate bifidobacteria. Inulin is a fructan, which in its natural form does not exist in isolation but within a network of plant cell-wall fibers, including pectin, hemicellulose and cellulose. The spatial organization of these fibers in plant cells is expected to affect the microbial fiber-breakdown in the colon, thereby modulating the microbiota and fermentation products as well as related physiological effects. To assess the effect of inulin in its natural form on microbiota composition, short-chain fatty acid (SCFA) production and gut regularity, we used dried chicory roots, because they are one of the highest-fiber foods (Puhlmann & de Vos, 2020) and particularly high inulin organized in its natural multiple fiber network. In a randomized controlled trial we provided 30 g of dried chicory root per day for a period of three weeks to a group of 28 adults (placebo: Maltodextrin, n= 28). The study period was preceded by a two-week run-in period providing a dose of 15g of fiber. The results indicate that consumption of the dried chicory root strongly stimulated gut regularity by increasing stool frequency and softness. The latter was more pronounced at low initial stool softness, indicating that constipated individuals might especially benefit of this fiber intake. Total SCFA production increased significantly, which was driven by the known stimulatory effect on acetate. Interestingly, we also observed an increase in butyrate and propionate, which has not consistently been reported for the consumption of isolated inulin. Finally, we observed a strong shift in overall microbiota composition, which already started after the run-in period. The main changes included an increased 3-fold relative abundance of *Anaerostipes* spp.. *Anaerostipes* includes butyrate-producing species that are able to cross-feed on acetate and lactate produced by *Bifidobacterium*. Indeed, we also observed a strong stimulatory effect on the relative abundance of *Bifidobacterium* spp. at both doses. The extent of stimulation was related to baseline levels of *Bifidobacterium*, i.e. subjects having low baseline levels underwent the strongest stimulation. In conclusion, dried chicory root as a source of multiple fibers in their natural network organization is able to exert strong stimulatory effects on microbiota composition, fermentation and gut regularity.

Measurement of available carbohydrates in grains, cereal products, vegetables, fruit food products with an AOAC validated method

Ciara McLoughlin and Barry V. McCleary, Megazyme, Ireland

Overconsumption of available carbohydrates is directly linked to obesity and Type II diabetes, two of the most significant diseases of the Western World. In this presentation, a method is described for the accurate measurement of available carbohydrates in a wide range of food and feed products. This method was recently successfully evaluated through an AOAC single laboratory study (SLV) and will be subjected to a full interlaboratory evaluation in the coming months. Available carbohydrates are defined as the sum of non-resistant starch, maltodextrins, isomaltose, sucrose, lactose, glucose, fructose and galactose. In the method described here, non-resistant starch is hydrolysed to glucose and traces of maltose by pancreatic a-amylase (PAA) and amyloglucosidase (AMG) under the conditions employed in AOAC Method 2017.16 (the rapid integrated total dietary fiber procedure); maltose is hydrolysed to glucose by maltase; isomaltose to glucose by oligo-1,6-a-glucosidase; sucrose to glucose and fructose by a specific sucrase (which, unlike invertase, has no action on fructo-oligosaccharides); and lactose to glucose and galactose by b-galactosidase. The glucose, fructose and galactose released are specifically and separately measured using enzymatic procedures allowing assignment of glycemic values. This method is simple to use and is the only procedure that allows direct measurement of available carbohydrates in food samples.

Appraising the human health impacts of fiber enrichment through reformulation modeling

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The possible effects of reformulating foods with increased fiber on various health outcomes needs to be better understood. Food and beverage reformulation is vital as it lets consumers consume the products they desire while reducing intake of less desirable nutrients, and potentially increasing intake of beneficial nutrients such as fiber. The objective of this study was to conduct a statistical modelling analysis to understand how fiber enrichment can potentially affect the health status of UK consumers. The UK National Diet and Nutrition Survey (NDNS) datasets from 2014 - 2015 and 2015 - 2016 were utilized to evaluate intakes of AOAC fiber and Kilocalories with a dietary intake model. Foods and beverages eligible for fiber enrichment were identified (n = 915) based on EU legislation for nutrition claims. Prevalence of health outcomes such as weight, cardiovascular disease and type 2 diabetes risk reductions were quantified through statistical analysis of the ‘intervention’, pre and post fiber reformulation using Reynolds et al (2019), D’Agostino et al (2008), and QDiabetes algorithms, respectively. Modelling demonstrated that 5.9% of subjects could achieve a weight reduction, 72.2% of subjects a reduction in cardiovascular risk, and 71.7% a reduced risk of type 2 diabetes risk with fiber

fortification (all with p ≤ 0.05). This study gave a good overview of the potential public health benefits of reformulating food products using a conservative and realistic fiber enrichment scenario. Understanding the impact of fiber on outcomes of human health can be an important motivator for the public to be more aware of this nutrient and for enrichment by food companies. This research was funded by Tate & Lyle PLC, 1 Kingsway, London, WC2B 6AT, United Kingdom.

Psyllium is superior to wheat bran for increasing stool output in healthy and constipated subjects

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In an oft-cited book chapter (Cummings, 2001), Table 1 states that wheat bran yields an increase in stool output of 5.4 g per gram of '*fiber*' consumed (5.4 g/g) in healthy subjects. This statement has been misinterpreted as 5.4 g of stool produced per gram of 'wheat bran' consumed. The footnote under the table states that wheat bran is only 44% fiber, so the correct stool output value for a dose of 'wheat bran' is 2.4 g/g (5.4 g/g x 0.44 = 2.4 g/g) in healthy subjects. This corrected value is consistent with a recent meta-analysis (McRorie et al., 2020) which compared the effects of wheat bran and psyllium on stool output and stool softening in healthy subjects (36 studies) and subjects with chronic idiopathic constipation (CIC; 8 studies). Results showed that wheat bran increased stool output by 2.9g/g in healthy subjects, but only 1.4g/g in subjects with CIC, showing that data from healthy subjects should not be presumed to be predictive of an effect in constipation. In contrast, psyllium increased stool output by 5.0g/g in healthy subjects and 4.8g/g in subjects with CIC, demonstrating a consistent effect in healthy and constipated subjects. Psyllium also showed a significant and consistent stool softening effect. In contrast, while coarse wheat bran showed a stool softening effect, finely ground wheat bran showed a stool-hardening effect. This is consistent with the mechanism of action for insoluble fiber. Coarse wheat bran particles mechanically irritate the gut mucosa, stimulating secretion of mucous and water and thereby increasing stool water content, a stool softening effect. In contrast, finely ground wheat bran particles are too small/smooth to mechanically irritate the gut mucosa, adding only to the dry mass of stool and decreasing stool water content, a stool-hardening effect. Note that wheat bran product labels do not provide information on the degree of milling. In conclusion, psyllium is 3.4-times more effective than wheat bran for increasing stool output in subjects with CIC, making psyllium the 'gold standard fiber for regularity'.

Evaluation of human health safety claims related to dietary fiber using the FDA Adverse Event Reporting System (CAERS)
Derek A. Drechsel, PhD CTEH, LLC, USA

Soluble fiber is as essential part of the diet known to provide key health benefits including hunger regulation, slowing digestion, regulation of blood sugar levels, decreasing cholesterol levels and promoting health intestinal function. In recent years, there have been several instances of consumer and media scrutiny based on reports of adverse health effects associated with diets and supplements containing high levels of fiber. Many of the reported symptoms relate to gastrointestinal discomfort which are likely due to a sudden increase in fiber intake or intake above recommended levels in affected consumers. However, serious adverse events not typically associated with dietary fiber have been reported. The FDA maintains a database of adverse event reports (CAERS) related to foods and dietary supplements submitted by healthcare professionals, consumers, and manufacturers. The CAERS database was searched for adverse events submitted to the FDA from 2018 to 2020 related to high-fiber containing products. 129 reported adverse events were identified related to fiber products spanning a wide range of symptoms and health outcomes. In addition, a similar search was conducted for vitamin C-containing supplements. Over the same time period, 295 adverse events were reported for vitamin C which likely reflects the greater number of users versus fiber-containing products. An analysis of the reported events demonstrated that the type of symptoms and health outcomes did not significantly differ between fiber- and vitamin C-containing products. The results demonstrate that adverse event reports for fiber-containing products are similar to those for a supplement product with a well-documented safety profile. In addition, co-incidental adverse events are not uncommon for most foods and dietary supplements.

Highly specific prebiotic dietary fibers allow predictable shifts in the gut microbiota
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Prebiotics are dietary fibers which are fermented in the large intestine to promote local and systemic effects beneficial to human health. However, most dietary fibers currently utilized as prebiotics present different and therefore unpredictable responses when administered to individuals harboring distinct microbial communities. We have previously proposed that fibers of higher structural specificity (i.e. utilized by a narrow group of gut bacteria) could have more similar responses across subjects than those of low specificity (i.e. utilized by many gut bacteria). To test this hypothesis, here we evaluated the fermentation profile of fibers of low (fructooligosaccharides and resistant starch), medium (pectin) and high specificity (an insoluble β-1,3-glucan) in an *in vitro* fermentation model utilizing fecal inoculum from 10 distinct individuals separately. Sequencing of the 16S rRNA gene and short chain fatty acid analysis were conducted to evaluate similarity/dissimilarity in fiber responses across the microbiota of

the 10 individuals. β-diversity analysis confirmed that divergent fiber responses occur across individuals harboring distinct microbial communities when utilizing both of tested low specificity dietary fibers (fructooligosaccharides and resistant starch), but fibers of higher specificity (pectin and β-1,3-glucan) lead to more similar responses across subjects. In fact, relative abundance data showed, that the highly specific β-1,3-glucan targeted *Anaerostipes sp*. and *Bacteriodes uniformis*, promoted a strong growth effect (from 0.3 to 16.5% average and from 2.5 to 17.9% average, respectively) in every microbial community that had these bacteria originally present. These were accompanied by marked increases in the metabolites butyrate and propionate which are known to be beneficial to the human health. We have showed for the first time that the use of high specificity dietary fibers as prebiotics, but not low specificity fibers, can promote homogeneous and predictable responses in distinct microbial communities.

The development and commercialization of high amylose wheat: an innovative solution to the dietary fiber gap

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Poor diet is recognized as a major modifiable risk factor for the prevention of non-communicable diseases globally and increasing the nutritional quality of foods people routinely eat is a direct and promising strategy to improve public health. Foods containing refined cereal flours, particularly wheat, are central to the diets of most people. Thus, minor changes to the nutritional content of wheat could greatly improve diet quality and consequently the overall health of many populations. To achieve this, we identified a wheat variety that has null alleles of starch branching enzyme (SBE)-IIa in all three wheat genomes and one genome with one null allele of SBEIIb. This high amylose wheat (HAW) contains >80% amylose, a type of starch that is less digestible in the human small intestine. Subsequently, refined wheat flour made from HAW contains up to 15 times more dietary fiber than conventional wheat, predominately in the form of resistant starch type 2, a prebiotic fiber that has numerous health benefits. Clinical trials have confirmed that breads and noodles made with HAW have a lower glycemic response and that consumption of foods containing refined HAW for 4 weeks improved measures of gut health. Furthermore, HAW flour can readily replace conventional wheat flour in a broad range of commonly consumed cereal products to increase the fiber content of typical wheat-based foods (breads, tortillas, pasta) by up to 6 times. We have recently shown that replacing conventional flour with HAW improved measures of end product quality for flour tortillas. We found that tortillas containing HAW delivered 4 times the fiber and had higher scores on standard tests for rollability and foldability when compared to a standard flour tortilla, thus demonstrating improved shelf life and pliability over the ten-week testing period. Thus, HAW provides a new opportunity where refined wheat flour can be replaced in food products to provide metabolic and gut health benefits to the consumer.

Digestive health benefits of high amylose wheat: a randomised controlled trial in healthy adults

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Replacing conventional wheat with high amylose wheat (HAW) containing high levels of resistant starch lowers the glycemic response to bread, but its effect on the gut health of healthy adults is unknown. This study aimed to investigate whether HAW food consumption improved measures of gut health, bowel habit and perceived gut comfort. Eihty healthy adults were enrolled in a 4-arm parallel, randomised, controlled, double-blind trial. They consumed diets containing bread and biscuits made from low amylose wheat (refined, LAW-R or wholemeal, LAW-W) or HAW (refined, HAW-R or wholemeal, HAW-W) flour for 4wk. At baseline and after 4wk, changes in faecal markers of health, including short chain fatty acids, p-cresol and microbial composition were determined. A gut comfort questionnaire was also completed at baseline, 2 and 4 wk. The HAW-R group had higher levels of SCFA-producing microbes and excreted 38% more butyrate ($p<0.005$) in their faeces. Furthermore, the HAW-R group had lower abundance of p-cresol producing bacteria and 24% lower concentrations of p-cresol ($p<0.05$) in their faeces. Wheat amylose content did not affect measures of bowel habit, including stool consistency, faecal output, faecal moisture and defecation frequency. The HAW diets were well tolerated with no adverse effects on digestive comfort. Foods made with refined HAW flour rather than conventional wheat were effective in improving some measures of gut health.