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# Physiological Effects of Agroindustrial Co-Products: Cactus (*Opuntia ficus*) Pear Peel Flour and Stripe Apple (*Malus domestica*) Marc Flour on Wistar Rats (*Rattus norvegicus*)

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**Abstract:** Agro-industrial co-products as fruit peel can be used as alternative and cheap fiber and prebiotics resources. The objective of this work was to evaluate rats' *in vivo* physiological effect the *in vivo* effect of apple marc and cactus pear peel during 90 days. Inulin (as control) containing diet resulted in higher average body weight, but apple marc diet showed the same body weight gain. Diets reduced glucose and triglycerides in serum. Lactic acid bacteria and Bifidobacteria count were higher in cactus peel flour diet, although apple marc diet resulted in better fatty acids production. Due to higher insoluble fiber, apple marc flour and cactus pear peel flour resulted in higher non-digestible carbohydrates. Apple marc flour showed similar physiological effects as compared to inulin and can be employed as a good prebiotic source.

**Key words:** Fiber, cactus pear peel, apple marc, weight gain, short chain fatty acids, rats

## INTRODUCTION

The food industry is constantly looking for products that can be easily market and provide health benefits to consumers. The increasing demand for these products promotes a growing interest in research and to identify alternative ingredients that may lead to enhanced health, like oligosaccharides (Boler and Fahley, 2012). Oligosaccharides are low-molecular-weight carbohydrates with a low degree of polymerization that resist digestion and absorption by mammalian enzymes and also named "nondigestible oligosaccharides". NDO have been classified as prebiotics, which are defined as "nondigestible food ingredients that affects the host by beneficially selectively as stimulation the growth and activity of one or a limited number of bacteria in the colon and thus improving host health" (Gibson *et al*., 2004). Some health benefits of prebiotics ingestion are reduction of inflammatory bowel disease (Borruel, 2007), increase of absorption of a variety of minerals (Griffin and Abrams, 2008) and regulate of triacylglycerol and cholesterol metabolism (Beylot *et al*., 2008), beside colorectal cancer prevention (Asad *et al*., 2008). Only three NDO can be classified as prebiotics: fructans, galactooligosaccharides and lactulose. Fructans, like inulin, are the beta-(2, 1)-fructans extracted from chicory roots and present in many other plants, where the beta-(2, 1)-bond cannot be hydrolyzed in human digestive system (Ritsema and Smeekens, 2003; Boeckner *et al*., 2000). Dietary fiber is defined as "primarily derived from plant material and is composed of complex, non-starch carbohydrates and lignin that are not digestible within the small intestine because mammals do not produce enzymes capable of hydrolyzing them into their constituent monomers" (Turner and Lupton, 2011). The main types include non-starch polysaccharides, cellulose, hemicellulose, pectin, resistant starch and other NDO associated with dietary fiber polysaccharides, especially lignin (Van Soest, 1978). The effect of dietary fibers differs in their physicochemical characteristics on transit through various segments of the GI tract and fermentation in the large intestine and is well documented in the scientific literature such as reduction effects on fasting glucose, triglycerides and cholesterol serum concentrations (Paturi *et al*., 2012). Rats may provide a useful model to examine interacting variables of importance to human health, since the caecum is the most active fermentation locus and rat colon can be functionally equated with human distal colon (Monro *et al*., 2012). Hara *et al*. (1994) evaluated the fermentability of acid-treated maize husk by *in vivo* and *in vitro*. Their results showed that the fermentable energy and the short-chain fatty acids production rate in the caecum in acid-treated maize husk is twofold higher that control, concluding that *in vitro*

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caecal SCFA production is correlated with the *in vivo* utilization of energy from the dietary fiber sources. Campbell *et al.* (1997) evaluated the *in vivo* effects of selected oligosaccharides on caecal and faecal pH and SCFA, besides intestinal microbiota concentrations in rats. Total caecal pH of pools was lower in oligosaccharides containing diets compared with control or cellulose. Also caecal bifidobacteria and total anaerobes were higher while total aerobes were lower in rats fed with oligosaccharide diets compared with those control diet.

In this view, agroindustrial co-products as apple marc flour or cactus pear peel flour can be employed as an alternative fiber and other fermentable sugars by intestinal bacteria. The composition of these flours will affect their physiological performance. The objective of this study was to evaluate the effect of apple marc and cactus pear peel on the physiological parameters of Wistar rats (*Rattus norvegicus*) and their possible utilization as prebiotics.

## MATERIALS AND METHODS

**Animals:** A total of 24 male (two-week old) Wistar rats (*Rattus norvegicus*) were housed in special individual stainless steel cages at 18°C with a 12 h light/dark cycle. The rats were randomly distributed in three groups (n = 8) for 90 days (13 weeks) with an initial weight average of 53.48 g. This study was approved by the Animal Care Committee of the Instituto Nacional de Ciencias Medicas y Nutricion Salvador Zubiran (Mexico), in accordance with international guidelines for the use of animals in research. Body weight was recorded weekly, the food was served at 8:00 am and left overs were weighed daily.

**Fiber source:** Cactus pear (*Opuntia ficus*) peels were recovered from local fresh fruits establishments in Mexico City. Apple (*Malus domestica*) marc was collected from "Bodegas Delicia" at Zacatlán, Puebla, Mexico. Cactus pear peel were washed with tap water, cut in small 2 x 2 cm cubes and dried at 60°C until constant weight. Apple marc was dried at 60°C until constant weight. Dried peels and marc were grounded in mill and sieved consecutively in No. 20, 50, 80, 100 sieves to obtain a regular and homogeneous powder named flour and stored in dark sealed containers until use.

**Experimental diets:** Experimental diets (Table 1) were prepared according to the recommendations for rats diets of the American Institute of Nutrition (Reeves *et al.*, 1993). Fiber source (cellulose) was substituted by: (a) cactus pear (*Opuntia ficus*) peel flour, (b) apple (*Malus domestica*) marc flour and (c) inulin as control.

**Euthanasia:** At the end of the study, animals were euthanized ($CO_2$ chamber asphyxiation) to perform the following analysis: serum lipid profile and glucose, count of caecium microbiota, caecium acids organic production and faecal non-digested polysaccharides.

**Serum lipid profile and glucose:** Blood was collected in tubes with gel and clot activator (Beckton Dickinson, Franklin Lakes, NJ) and centrifuged at 1,000 x g for 15 min to obtain serum. Fraction samples were maintained at -80°C until analysis. Serum total cholesterol, triglycerides, high-density lipoprotein cholesterol and glucose were determined using assay kits from Beckman Coulter with a Synchron C x 5 Delta Beckman Coulter analyzer (Beckman Instruments, Fullerton, California).

**Caecium microbiota count:** Bacterial strains were grown at 37°C under anaerobic conditions in gas jars with a GasPak system in the Man Rogosa-Sharpe (MRS) broth for *L. reuteri*, MRS broth supplemented with 0.05% cysteine by *B. adolescentis* and brain heart infusion broth (all from Oxoid) for *B. fragilis* (Monro *et al.*, 2012).

**Short chain fatty acids production in caecium:** SCFA (acetic, propionic, butyric and isobutyric) were determined in caecal contents of rats according to the method described by Richardson *et al.* (1989). The samples were analyzed using a gas chromatography system HP 5890 Series II (Perkin Elmer, Shelton) with an AT-1000 (10 m x 0.250 mm) column, ionized flame detector, $N_2$ as carrier gas with a one mL/min flux and a ramp temperature from 90 to 120 at rate of 5°C/min.

**Faecal non-digested polysaccharides:** Total faecal dietary fiber was measured on finely ground faecal material (Paturi *et al.*, 2012). Samples (100 mg) were weighed into 12 ml glass culture tubes and extracted twice with 5 ml 80% ethanol, collected residue was centrifuged between washes. The residues were washed with 2 ml acetone, air-dried at 60°C and finely grounded. The residues were then subjected to total polysaccharide hydrolysis using one mL 12 M $H_2SO_4$ (35°C for one h), followed by the addition of 7 ml distilled water and heating at 100°C for one h. Total polysaccharide in the hydrolyzed was measured as reducing sugars (Dubois, 1956).

**Statistical analyses:** For rats weight, a regression analysis was performed with the SAS Software v 8.0 (SAS System, Cary) PROC REG procedure with the option NOINT to force the regression response to pass through the origin, since the estimated value of the variable is forced to be zero when the independent variable have the value zero, as a requirement in growth model where the response (weight) must be zero at the beginning (time zero) (Freund and Littell, 2004).

To determinate the effect of the different diets on rats' weight gain, a two-way analysis of Variance (ANOVA) was employed with the following proposed model:

$$y_{ij} = \mu+\alpha_i+\beta_j+\in_{ij}$$

where, $y_{ij}$ represents the variable response (rat weight) for the i-th level of diet (inulin, cactus pear peel or apple marc) at the j-th level of time (weeks); $\mu$ is the overall mean; $\alpha_i$ and $\beta_j$ are the main effects of level of diet and time and $\in_{ij}$ is the residual or error terms assumed to be normally distributed with zero mean and variance $\sigma^2$ (Der and Everitt, 2002). Results were analyzed with the PROC ANOVA procedure in SAS Software v 8.0 (SAS System, Cary). Significant differences between means were determined by the Duncan means test.

For the serum parameters, caecium microbiota, volatile fatty acids and non- digestible polysaccharides a one-way ANOVA was employed determining significantly differences between the different diets by Duncan means test in same statistical software.

## RESULTS AND DISCUSSION

**Food intake and body weight gain:** There was an effect of the type of diet and time on body weight gain. Inulin diets obtained the significantly ($p<0.05$) higher average weights, followed by apple marc. As expected, the significantly ($p<0.05$) higher weight was at the end of the 13 weeks of time (Table 2). Nonetheless, in regression analysis, slope for apple marc diets was higher than inulin diets (45.67 and 45.44 for apple marc flour and inulin, respectively), meaning that in early stages of growth apple marc showed better nutrients absorption with a higher body weight (Fig. 1). Diets with inulin resulted in higher body weight gain because higher absorption nutrients, mainly soluble sugars (McIntyre *et al*., 1991; Lupton and Kurtz, 1993; Shimotoyodome *et al*., 2005). Dietary fiber supplementation may have promoted satiety by decreasing food intake (Paturi *et al*., 2012). Lower body weight gain with cactus pear peel flour and apple marc flour diets were probably due to their relatively lower real content of soluble sugars, lower content of fructans and higher fiber. Fiber composition affects body weight gain, since Monro *et al*. (2012) reported that rats fed with diets containing barley beta-glucan resulted in higher body weight gain with no difference in food intake. Similar results were found by Belobrajdic *et al*. (2012), using different types of fructans in rats diets. In body weight gain regression analysis. Rats fed with inulin and apple marc showed the same speed change in body weight, meaning that both fiber sources had similar effect on rats' physiology. Apple marc could be employed as cheap source of prebiotic to replace inulin, a commercial and more expensive ingredient. Remesy *et al*. (1992) reported that rats fed the diets containing the more insoluble fibers had a compensatory increase in intake, resulting in similar weight gain.

**Glucose, triglycerides and cholesterol:** Serum chemistry of rats fed with the different diets is shown in Table 3.

Rats fed with inulin containing diets presented significantly ($p<0.05$) lower glucose values than cactus pear or apple marc diets. In same manner, inulin diets presented significantly ($p<0.05$) lower triglycerides values as well, as compared with the rest of the treatments. There was no significantly difference ($p>0.05$) in total cholesterol among the different diets. There was no significantly difference ($p>0.05$) in high density lipoprotein between the different diets. Inulin diet resulted in lower glucose and triglycerides content, but no significantly differences were found in total cholesterol and high density lipoprotein. Higher glucose values in both apple marc and cactus pear peel could be due to higher fiber content as compared to inulin. This results indicate that inulin is completely metabolized (no insoluble fiber), whereas cactus pear peel flour and apple marc flour contains a considerably amount of insoluble fiber (33.48 and 59.81%, respectively), affecting glucose metabolism. Higher insoluble fiber resulted in moderately higher blood glucose (as for apple marc flour). Soluble fibers decreasing effectively post-prandial glucose and the effect of dietary fiber in glucose absorption and physiological consequences of fiber fermentation have important implications for human diseases (Larrauri *et al*., 1996). Effectiveness of dietary fibers in controlling hyperglycemia is generally affected by their composition source and preparation (Bornet *et al*., 1997), since insoluble dietary fibers could retard the utilization and absorption of carbohydrate and help to control the postprandial serum glucose level (Chau *et al*., 2004). There is positive effect of dietary fiber on cholesterol and triglycerides in rats' serum. According to Vigne *et al*. (1987), rats fed with pectin containing diets as fiber source presented lower values for high density lipoprotein cholesterol and triglycerides, as compared to non-containing fiber diets. In same manner, studies in rats have demonstrated that feeding inulin or oligofructose as 10% of the diet reduced hepatic and serum triglycerides synthesis (Fiordaliso *et al*., 1995). In this research, same effect was observed employing 5% of inulin or the proposed alternative fiber sources. Plant fibers may influence serum cholesterol concentrations by three principal mechanisms: (a) altering intestinal absorption, metabolism and release of cholesterol; (b) altering hepatic metabolism and release of cholesterol; or (c) altering peripheral metabolism of lipoproteins (Anderson and Lin Chen, 1979). Addition of different types of fiber, like pectin and soluble fibers exerts different hypocholesterolemic effects that affects cholesterol metabolism (Vigne *et al*., 1987). Low density lipoproteins values were not determined. First, no statistical difference in cholesterol between treatments was found. Secondly, to employ the Friedwald equation (Friedewald *et al*., 1972) to estimate LDL values is not recommended (Nauck *et al*., 2002). Since reputable results for serum cholesterol lower to 100 mg/dL (Sanchez-Muniz and Bastida, 2008) will

Table 1: Experimental diets composition (g per 100 g diet); based on recommendations of the American Institute of Nutrition for rat

| Ingredient (%) | Inulin | Cactus pear peel flour | Apple marc flour |
|---|---|---|---|
| Maize starch | 39.7 | 39.7 | 39.7 |
| Casein | 20.0 | 20.0 | 20.0 |
| Dextrinized maize starch | 13.2 | 13.2 | 13.2 |
| Sucrose | 10.0 | 10.0 | 10.0 |
| Soy oil | 7.0 | 7.0 | 7.0 |
| Agave Inulin | 5.0 | 0.0 | 0.0 |
| *Opuntia ficus* pear peel flour | 0.0 | 5.0 | 0.0 |
| Apple marc flour | 0.0 | 0.0 | 5.0 |
| Mineral mix | 3.5 | 3.5 | 3.5 |
| Vitamin mix | 1.0 | 1.0 | 1.0 |
| L-cysteine | 0.30 | 0.30 | 0.30 |
| Choline bitartrate | 0.25 | 0.25 | 0.25 |

Table 2: Average body weight gain (g) for rats fed with the diets with different fiber sources

| | Diet | | |
|---|---|---|---|
| Weeks | Inulin | Apple marc | Cactus pear peel |
| 1 | 64.96±0.99$^{a,M}$ | 58.48±1.65$^{b,M}$ | 63.79±1.46$^{c,M}$ |
| 2 | 105.75±1.01$^{a,L}$ | 97.62±0.96$^{b,L}$ | 109.20±3.30$^{c,L}$ |
| 3 | 151.93±4.95$^{a,K}$ | 149.41±6.61$^{b,K}$ | 158.81±5.50$^{c,K}$ |
| 4 | 212.50±6.75$^{a,J}$ | 206.25±6.32$^{b,J}$ | 217.12±5.99$^{c,J}$ |
| 5 | 270.43±6.54$^{a,I}$ | 261.87±5.59$^{b,I}$ | 266.43±6.01$^{c,I}$ |
| 6 | 319.45±6.99$^{a,H}$ | 313.00±6.21$^{b,H}$ | 312.00±5.74$^{c,H}$ |
| 7 | 361.00±7.21$^{a,G}$ | 355.00±7.01$^{b,G}$ | 337.00±6.91$^{c,G}$ |
| 8 | 401.25±6.73$^{a,F}$ | 396.87±6.52$^{b,F}$ | 361.25±5.96$^{c,F}$ |
| 9 | 437.50±7.54$^{a,E}$ | 444.37±6.98$^{b,E}$ | 390.62±5.96$^{c,E}$ |
| 10 | 457.50±8.25$^{a,D}$ | 467.12±7.63$^{b,D}$ | 409.25±7.25$^{c,D}$ |
| 11 | 486.50±8.13$^{a,C}$ | 493.87±7.61$^{b,C}$ | 428.75±6.94$^{c,C}$ |
| 12 | 506.12±7.94$^{a,B}$ | 514.75±7.12$^{b,B}$ | 445.75±7.01$^{c,B}$ |
| 13 | 514.62±7.82$^{a,A}$ | 519.62±8.01$^{b,A}$ | 455.87±6.99$^{c,A}$ |

$^{a,b,c}$Means with same letter in same row are not significantly (p>0.05) different for diet

$^{A,B,C}$Means with same letter in same column are not significantly (p>0.05) different for weeks

Table 3: Serum parameters (mg/dL) for rats fed with the diets with different fiber sources

| | Diet | | |
|---|---|---|---|
| | Inulin | Cactus pear peel flour | Apple marc flour |
| Glucose | 175.6±1.13$^{c}$ | 187.0±2.11$^{b}$ | 203.0±1.41$^{a}$ |
| Triglycerides | 103.0±38.8$^{b}$ | 151.0±60.2$^{a}$ | 134.1±28.3$^{a}$ |
| Total cholesterol | 54.8±8.1$^{a}$ | 56.7±17.1$^{a}$ | 54.1±9.3$^{a}$ |
| High density lipoprotein | 49.1±7.6$^{a}$ | 51.1±13.2$^{a}$ | 49.6±7.6$^{a}$ |

$^{a,b,c}$Means with same letter in same row are not significantly (p>0.05) different for diet

Table 4: Caecium microbiota for rats fed with the diets with different fiber sources

| | Diet | | |
|---|---|---|---|
| Microorganisms | Inulin | Cactus pear peel flour | Apple marc flour |
| Lactic acid bacteria | 6.04±0.37$^{b}$ | 6.23±0.09$^{a}$ | 5.96±0.37$^{b}$ |
| Bifidobacteria | 6.24±0.79$^{a}$ | 6.24±0.08$^{a}$ | 5.95±0.35$^{b}$ |
| *Bacteroides* sp | 5.75±0.50$^{c}$ | 6.20±0.19$^{a}$ | 5.97±0.33$^{b}$ |
| *Enterobacteria* sp | 3.59±0.28$^{b}$ | 3.84±0.29$^{a}$ | 3.56±0.28$^{b}$ |

$^{a,b,c}$Means with same letter in same row are not significantly (p>0.05) different for diet

result in negative values. No difference was found in healthy rats with a regular (no extra fat or cholesterol) diet. Dietary fiber that escapes digestion in the small intestine enters in the large intestine where it is utilized as a fermentable substrate by the microbiota, principally Bifidobacteria and lactobacilli (Gibson and Roberfroid, 1995). Bifidobacteria possesses the characteristics to treat infections as diarrhea, improve lactose digestion and protect against infection (Li *et al*., 2014). Campbell *et al*. (1997) reported Bifidobacteria higher counts in rats fed with oligosaccharides. The accepted mechanism by which *Bifidobacterium* spp. is thought to be inhibited is related to the higher production of acetic and lactic acids during fermentation. Increasing acid production resulted in lower pH which prevents enteric colonization of potentially pathogenic microorganisms and growth of putrefactive bacteria (Gibson *et al*., 2004; Paturi *et al*., 2012).

Table 5: Volatile fatty acids (µmol) and non-digestible polysaccharides for rats fed with the diets with different fiber sources

| | Diet | | |
|---|---|---|---|
| Microorganisms | Inulin | Cactus pear peel flour | Apple marc flour |
| Acetic acid | 5.94±2.38$^{c}$ | 17.99±3.94$^{b}$ | 20.89±10.15$^{a}$ |
| Propionic acid | 1.67±0.41$^{c}$ | 3.72±1.22$^{b}$ | 4.58±1.37$^{a}$ |
| Butyric acid | 5.47±2.33$^{a}$ | 0.63±0.23$^{b}$ | 6.66±4.10$^{a}$ |
| Isobutyric acid | 0.13±0.01$^{c}$ | 0.19±0.04$^{b}$ | 1.19±0.5$^{a}$ |
| Non digestible polysaccharides | 2.89±0.83$^{c}$ | 12.11±0.29$^{a}$ | 7.12±2.06$^{b}$ |

$^{a,b,c}$Means with same letter in same row are not significantly (p>0.05) different for diet

**Caecium microbiological counts:** There was a significantly (p<0.05) effect of the type of diet on rats' caecium microbiological count. For Bifidobacteria, apple marc resulted in significantly (p<0.05) lower count than inulin and cactus pear flour. The Bacteroides count was significantly (p<0.05) higher for cactus pear peel diets, followed by apple marc diets. Diets with cactus pear peel obtained significantly (p<0.05) higher lactic acid bacteria and Enterobacteria counts than inulin and apple marc (Table 4). Cactus pear peel flour enhanced the growth of beneficial microorganisms as lactic acid bacteria and Bifidobacteria, although allowed the growth of Bacteroides and Enterobacterias as well. Apple marc allowed a better growth of lactic acid bacteria and reduced the growth of Enterobacterias and Bacteroides. Non digestible sugars or combination of different dietary fibers have been noted to increase Bifidobacteria and lactobacilli populations in rats (Dongowski *et al*., 2005; Rodriguez-Cabezas *et al*., 2010).

**Short chain fatty acids (SCFA) and non-digestible polysaccharides:** There was a significantly (p<0.05) effect of the type of diet on rats' fatty acids production in caecium. Apple marc diet resulted in significantly (p<0.05) higher acetic, propionic, butyric and isobutyric acids production. In Apple marc and inulin diets the butyric acid production was significantly (p<0.05) higher than cactus pear peel (Table 5). This means that apple marc produced butyric acid in same rate than inulin. Non

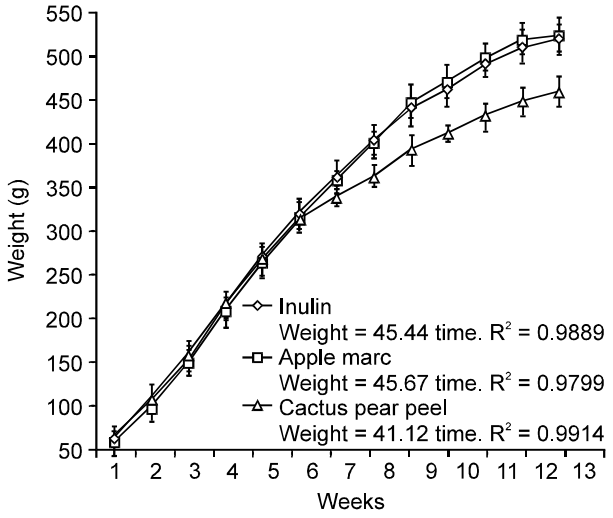


Fig. 1: Body weight gain change and regression equations for the different diets

digestible polysaccharides was significantly ($p<0.05$) higher in cactus pear peel diets, followed by apple marc diets (Table 5). Inulin has been reported as a highly fermentable fiber (Gibson and Roberfroid, 1995; Franck and Bosscher, 2009), highly fermentable dietary fibers are characterized by being readily fermented by enteric bacteria, producing short-chain fatty acids especially butyrate, which are the end products of fermentation of polysaccharides by the colonic flora and that are used as an energy source by intestinal epithelial cells (Bugaut, 1987; Younes *et al*., 1994). The SCFA are known to influence several functions on the colon, for example ionic transport, colonic motility and mucosal-cell proliferation (Yajima, 1985), the caecum is a major site of SCFA production in rats (Remesy and Demigne, 1976). Butyric acid is of particular importance in human physiology due to its role as an energy source for colonic epithelium (Hague *et al*., 1997). Acetate is used and energy fuel by peripheral tissues, propionate is anti-lipogenic (Pascoal *et al*., 2013). Rats fed potato fiber had higher concentrations of acetic acid, whereas inulin-fed rats had significantly higher concentrations of butyric acid (Paturi *et al*., 2012). At the experimental employed conditions, rats fed with apple marc had higher concentrations of acetic acid, probably due to the both pectin and hemicellulose content. Younes *et al*. (1994) reported that the addition of oat fiber in rats' diet not increased the concentration of SCFA in the cecal contents, but the SCFA changes result in more propionate and butyrate. Dietary fibers differ in the fermentation rate to produce different SCFA profiles in the large intestine. The amount of SCFA in the large intestine is dependent on factors such as types of dietary fiber, intake and absorption by the host (Paturi *et al*., 2012). Rats fed with corn starch (Brown *et al*., 1997) or resistant starch (Jurgonski *et al*., 2014) showed higher concentrations of butyrate.

There are two categories of faecal samples based on their polysaccharide content. The relative resistance of cellulose to fermentation and its consequent survival in the faeces contrast with the susceptibility to fermentation of the remaining fibers (inulin) and the resulting lower polysaccharide content in faeces from rats fed with these dietary fibers (Paturi *et al*., 2012). For the nondigestible polysaccharides in faecal samples, higher content of insoluble or partially insoluble fibers (lignin, hemicellulose and cellulose) content in cactus pear peel flour and apple marc flour increased the amount of non-digestible polysaccharides (Anderson *et al*., 1979). The fiber of fruits contains pectin and cellulose. Pectin is a soluble fiber easily fermented with a great impact on bacterial metabolism and production of SCFA, while insoluble fiber (cellulose) fermentation is lesser as compared to soluble fiber, increasing fecal bulk more than soluble fiber (Grasten *et al*., 2002). Monro *et al*. (2012) reported greater faecal bulk was induced by the mixed fiber as compared with inulin in rats.

**Conclusions:** Rats' weight was affected by the fiber source employed in the diet, where although a higher weight was observed in inulin diets, apple marc diets presented the same speed change than control (inulin), this is, rats in both diets gain weight at same rate. No differences in cholesterol and triglycerides were observed, meaning that apple marc or cactus pear peel flour had same hypocholesterolemic effect than inulin. Cactus pear peel diets promoted the growth of lactic acid bacteria and Bifidobacteria as well, but differences among diets with different fiber source were not higher to one logarithmic cycle. Differences in fiber fermentability resulted in different SCFA profiles, where apple marc produced higher amounts of acetic, propionic and butyric acids. In this view, apple marc flour showed similar physiological effects as compared to inulin and can be employed as a good prebiotic source.

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