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Biological Evaluation of Raw and Steamed Broccoli and Cauliflower as Sources of Dietary Fibers

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ABSTRACT

The present study was conducted to estimate the dietary fiber fractions in raw and steamed broccoli and cauliflower, as well as to evaluate the biological values of them using experimental animals. Generally it was found that raw and steamed broccoli and cauliflower had a significantly high amounts of dietary fiber fractions. Raw broccoli contained higher amounts of neutral detergent fibers (NDF) and acid detergent fibers (ADF) (37.64 and 31.99%) than raw cauliflower (32.70 and 26.71%) respectively. On the other hand no significant difference was noted in acid detergent lignin (ADL) and hemicellulose between raw broccoli and raw cauliflower. The cellulose content was higher in raw and steamed broccoli (15.96, 10.59%) compared with raw and steamed cauliflower (9.82, 8.48%). Pectin content was 27.30% and 30.38% for raw broccoli and cauliflower respectively. Barely significant reduction in all the dietary fiber fractions was noticed in both broccoli and cauliflower after steaming. Biological evaluation of raw and steamed broccoli and cauliflower was investigated using experimental animals (rats). Data revealed that the lowest weight gain was for the rats which fed on diets contained raw broccoli (50.00g) followed by that contained raw cauliflower (61.67g), while the highest weight gain was observed for the group fed on basal diet (80.00g). Meanwhile feeding the rats on steamed broccoli or cauliflower raised their weight gain by 65.00 g and 72.50 g, respectively. Moreover, the results showed that feeding the rats on diets contained broccoli or cauliflower (raw or steamed) for 40 days remarkably lowered their blood lipid fractions as total cholesterol (TC), low density lipoprotein cholesterol (LDL-C), very low density lipoprotein cholesterol (VLDL-C) and triglycerides (TG) compared with those fed on basal diet but the high density lipoprotein cholesterol (HDL-C) was increased . Also, the blood glucose in the animal's blood was reduced by 20.99% and 12.92% for rats fed on raw and steamed broccoli diets and by 20.22 % and 13.65% for those fed on raw and steamed cauliflower respectively, compared to the basal diet groups.

Keywords: Broccoli, Cauliflower, Dietary fiber, Weight gain, Protein efficiency ratio , Feed conversion efficiency , Lipid profile.

INTRODUCTION

Dietary fiber can be defined as: all the components of food that are not digested by enzymes in the human digestive tract to produce smaller molecular compounds which are absorbed into the blood stream (AOAC, 2003). Dietary fibers are usually divided into two classes: water insoluble mainly (cellulose, lignin and some hemicellulose) and water soluble (mainly pectins, gums, some hemicellulose and others) (Thebaudin *et al*., 1997; Gorinstein *et al*., 2001). Dietary fiber constituents are found mainly in the cell wall of plant tissues (Sila *et al*., 2009). On general, fruits and vegetables are rich in water soluble fibers, whereas generally fibers contain more water insoluble fibers (cellulose and hemicellulose) (Figuerola *el al.,* 2005). The main function of dietary fibers is to change the nature of gastrointestinal tract content and exceed the rate of nutrient absorption (Eastwood and Kritchevsky, 2005). Water soluble dietary fiber (mainly pectin) usually fermented in the colon which caused normalization of the lipids and produces short chain fatty acids, as by products, with wide range of physiological actives which became probiotic materials (Bourquin *et al.,* 1993; Weickert and Pfeiffer , 2008). Moreover, dietary fiber can reduce the absorption of bile acids and this action caused a reduction in cholesterol level and decrease the blood diabetes risk (Anderson *el al.,* 2009).) . Diets rich in fibers can lower glycemia (in men) (Kiehm *et al.* 1976 and Jenkins *et al.* 1976). Moreover it was found that people who consume vegetables as a major portion of dietary fiber diets along with lower calories from saturated fat and animal products are at low risk of coronary diseases and cancer (Kahlon *et al*., 2008). Vegetables are good source of dietary fiber, it is required that vegetables should use frequently to provide all the essential nutrients, includes dietary fiber for normal body functions (Hanif *et al*., 2006 ; Alsuhaibani, 2013).

Broccoli and cauliflower (from *Brassicaceae* family) are good source of vitamins, minerals, crude fiber, polyphenols as well as they have high antioxidant power (Mansour *et al*., 2015[a,b]). In Egypt cauliflower is cultivated in wide area while broccoli is recently cultivated in limited area, therefore this study was carried out to evaluate and compare the content of dietary fiber fractions as an important and effective component in raw broccoli and cauliflower also the effect of steaming process on them. Moreover, the biological assay of raw and steamed broccoli and cauliflower was also carried out.

MATERIALS AND METHODS

Materials

Broccoli (*Brassica oleracea* var. *italica*) was purchased from a farm in Housh Eissa (El Behiera Governorate, Egypt) . Cauliflower (*Brassica oleracea* var. *botrytis*) was purchased from local market in Alexandria. All chemical used for study were purchased from Sigma (St Louis, MO, Germany).

Methods

Preparation of broccoli and cauliflower samples

Each of broccoli and cauliflower samples was washed and then was cut into flowers of 2-3 cm length from the top of the stem (florets). Then each of broccoli and cauliflower florets were divided into two parts, one of them was used as it is without any treatment which represented the control sample (raw sample) and another part was steamed as following:-.

Florets samples (broccoli and cauliflower) were steamed on boiling water vapor for 12 min and cooled in iced water to prevent over cooking. According to previous study (Mansour *et al* ., 2015[b]) it was found that steaming of broccoli and cauliflower for 12 min was more preferred by panelists so it was chosen to complete this study compared with raw broccoli and cauliflower

Determination of dietary fiber:-

Neutral detergent fibres (NDF) were determined according to Van Soest *et al.* (1991) using heat-stable α-amylase and sodium sulphite. Acid detergent fibres (ADF) were determined according to Goering and Van Soest (1970).Acid detergent lignin (ADL) was analysed by solubilisation of cellulose with sulphuric acid (720 ml/l) according to the method of Van Soest (1973). The fibre measurements were sequentially performed by using the ANKOM 220 Fibre Analyser unit (ANKOM Technology Corporation, Macedon, NY, USA) using the same sample in filter bags and expressed exclusive of residual ash. Total pectin was determined by the method Ranganna (1977). Cellulose and hemicellulose were calculated as follows:-

$$\% \text{ Cellulose} = \text{ADF} - \text{ADL}$$

$$\% \text{ Hemicellulose} = \text{NDF} - \text{ADF}$$

Biological assay

Animals and experimental design

Samples of broccoli and cauliflower used in the biological evaluation were freeze dried until approximately 20 % moisture content using Labconco freeze dry system Lyph-Lock 4.5, the samples were ground by mill and added to the basal diet. Thirty male rats (Sprague Dawley) weighing 100±5 g were obtained from Institute of Graduate Studies and Research, Alexandria, Egypt. The rats caged individually and were fed by the basal diet for one week before the beginning of the experiment. Five groups, six rats each, were fed on one of the following experimental diets for 40 days.

G 1: was fed on basal diet (control).
G 2 : was fed on basal diet + 20% raw broccoli.
G 3: was fed on basal diet + 20% steamed broccoli.
G 4: was fed on basal diet + 20% raw cauliflower.
G 5: was fed on basal diet + 20% steamed cauliflower.

Basal diet was prepared according to AOAC (2003), the composition of basal diet is given in Table (1). Since the protein contents of the diet varied according to protein source used (Pellet and Young, 1980). Food and water were available to the animals during the experiment. Uneaten and scattered foods were estimated every day and recorded daily and thus the consumed food was then calculated by difference. The animal body weight was recorded twice a week and the weight gain was calculated by difference.

Table 1. Composition of the basal diet

Ingredients	(%)
Corn starch	70 %
Protein source	10 %
Cotton seed oil	10 %
Salt mixture	4 %
Vitamin mixture	1 %
Choline chloride	1 %
Non-nutritive cellulose	4 %

The feed conversion efficiency (FCE)

The feed conversion efficiency (FCE) was determined according to Ndome *et al.* (2011). It was calculated using the following equations:

$$\text{Feed conversion efficiency (FCE)} = \frac{\text{Weight gain (g)}}{\text{Diet fed (g)}} \times 100$$

The protein efficiency ratio (PER)

The protein efficiency ratio (PER) and adjusted PER were determined according to AOAC method (2003) using the following equations:

$$\text{Protein efficiency ratio (PER)} = \frac{\text{Weight gain}}{\text{Protein intake}}$$

$$\text{Adjusted PER} = \text{PER} \times \frac{2.5}{\text{PER for reference protein}}$$

Blood serum analysis

A blood sample from each animal was taken at the end of the experiment after 12 hours of fasting. The rats were anesthetized and blood samples were taken and placed into a dry clean centrifugal glass tube with 0.2 ml heparin as anticoagulant and then left for 10 min at ambient temperature. The tubes were centrifuged at 8000 rpm for 10 min to separate the serum and the plasma. The clean supernatant serum was analyzed immediately.

The serum was used for the determination of triglycerides (TG), total cholesterol (TC),high-density lipoprotein cholesterol (HDL-C), low-density lipoprotein cholesterol (LDL-C), and very low density lipoprotein cholesterol (VLDL-C) according to SYNCHRON LX system chemistry information manual (2000) as follow

Blood serum triglycerides

The blood serum triglycerides level was determined using the spectrophotometric method, where 300 µL of reactive reagent solution was added to 3.0 µl of the sample and the formed colored compound was measured at 520 nm.

Blood serum total cholesterol

The blood serum total cholesterol was determined using the spectrophotometric method, where 300 µl of reactive reagent solution was added to 3 µl of the sample and the formed colored compound was measured at 520 nm.

Blood serum high and low density lipoprotein cholesterol

The blood serum high density lipoprotein cholesterol (HDL-C) was determined using the spectrophotometric method using unique detergent to solubilize only the HDL particles. Amount of 280 µl reactive reagent solution was added to 3 µl of sample and the formed colored compound was measured at 560 nm.

The blood serum low-density lipoprotein cholesterol (LDL-C) was calculated by the following equation:

$$\text{LDL-C} = \text{Total cholesterol} - \text{HDL} - \frac{\text{Triglycerides}}{5}$$

The blood serum very low density lipoprotein cholesterol (VLDL-C) was calculated using the following equation:

$$\text{VLDL-C} = \frac{\text{Triglycerides}}{5}$$

Blood serum glucose

The blood serum glucose was determined after enzymatic oxidation in the presence of glucose oxidase a according to Trinder (1969). The formed hydrogen peroxide reacts under catalysis of peroxidase with phenol and 4-aminophenazone to a red-violet quinoneimine dye as indicator. The determination investigated at 500 nm against blank reagent.

Statistical analysis

Data were statistically analyzed using Randomized Complete Block Design (R.C.B.D). Comparisons between means were carried out using least significant difference at 0.05 probability level ($LSD_{0.05}$) according to Steel and Torrie (1980).

RSULTS AND DISSCUSION

Dietary fiber in raw and steamed broccoli and cauliflower

Dietary fiber which is very important from the nutritional point of view are classified into water insoluble (cellulose, lignin, some of hemicellulose) which represent NDF, ADF and ADL and water soluble (mainly pectin and gums) (Thebaudin *et al*., 1997; Grigelmo-Miguel *et al.,* 1999).

Table (2) shows the percentages of natural detergent fibers (NDF), acid detergent fibers (ADF), acid detergent lignin (ADL), cellulose and hemicellulose in raw and steamed broccoli and cauliflower on dry weight basis. It is obvious that the main component among all the fractions was NDF in both raw broccoli and cauliflower , meanwhile raw broccoli had higher content of NDF (37.64%) than raw cauliflower (32.70%). Also ADF% was higher in raw broccoli (31.99%) than raw cauliflower (26.71%). On the other hand no significant difference was noted in acid detergent lignin (ADL) in raw broccoli and raw cauliflower, meanwhile steamed cauliflower had higher content of ADL than steamed broccoli. Cellulose was presented in higher percentage in raw broccoli (15.96%) compared with raw cauliflower (9.82%) but steaming process decreased cellulose content in both studied vegetables. The results also show that there was no significant difference observed in hemicellulose content between raw broccoli and raw cauliflower but after steaming broccoli possessed the highest content of hemicellulose. These results are in accordance with those of Mukherjee and Mishra (2012) and Madhu and Kochhar (2014).The results in the Table also represented the effect of steaming on dietary fiber fractions of broccoli and cauliflower. It could be concluded that steaming process resulted in barely significant reduction in NDF %, ADF %, and ADL% in both vegetables, yet the amounts of these dietary fibers fractions are still higher. The reduction was more obvious in steamed broccoli than in cauliflower. Cellulose content was decreased in steamed broccoli and cauliflower while hemicellulose was increased in both vegetables after steaming. This different trend in the hemicellulose content may be due to the redistribution of dietary fiber fractions. In accordance of our results Brandt *et al*. (1984) reported that cooking decreases the dietary fibers content in vegetables. Also, Kahlon *et al*. (2008) stated that dietary fiber decreased in steamed broccoli and spinach.

Table 2. Dietary fiber fractions (%), in raw and steamed broccoli and cauliflower (on dry weight basis)

Sample	Neutral detergent fibers (NDF) %	Acid detergent Fibers (ADF) %	Acid detergent lignin (ADL) %	Hemi cellulose %	Cellulose %
Raw broccoli	$37.64^{a}\pm0.10$	$31.99^{a}\pm0.10$	$16.03^{a}\pm0.09$	$5.65^{c}\pm0.1$	$15.96^{a}\pm0.06$
Steamed broccoli	$35.81^{b}\pm0.10$	$20.97^{d}\pm0.40$	$10.38^{c}\pm0.11$	$14.84^{a}\pm0.1$	$10.59^{b}\pm0.09$
Raw cauliflower	$32.70^{c}\pm0.10$	$26.71^{b}\pm0.10$	$16.89^{a}\pm0.13$	$5.99^{c}\pm0.1$	$9.82^{c}\pm0.07$
Steamed cauliflower	$32.11^{c}\pm0.1$	$23.85^{c}\pm0.05$	$15.37^{b}\pm0.13$	$8.26^{b}\pm0.07$	$8.48^{d}\pm0.06$

Means followed by the same letter (s) in column are not significantly different at (p≤ 0.05)

The previous results showed that in spite of the limited reduction in dietary fiber fractions after steaming, steamed broccoli and cauliflower still contained a considerable amount of dietary fiber fractions. Figuerole *et al*. (2005) reported that dietary fiber had high value of water retention capacity (WRC). This hydration property refers to its ability to retain water with its matrix. Therefore it could decrease the rate of glucose absorption from the intestine which is very useful in the case of diabetes mellitus patients. Moreover dietary fiber are known to bind with the bile acids in the small intestine and they remove them from the body with stools, this action stimulates the liver to increase cholesterol uptake from the circulation and to replenish the bile acid supply. As a result the concentration of serum total and LDL cholesterol are reduced (Pereira and Pins, 2000; Kahlon *et al*., 2008 and Salem *et al.,* 2013).

Pectin is a water soluble dietary fiber fraction, it can absorb water turning it into a gel-like mush (Sila *et al*., 2009). Table (3) represents the total pectin content in raw and steamed broccoli and cauliflower. Most of observed differences were statistically significant. Raw cauliflower had higher level of total pectin content (30.38%) than raw broccoli (27.30%). Moreover, it could be observed that steaming resulted in limited reduction in pectin content in both steamed vegetables. These results are in accordance with those of Borowski *et al*. (2015), who studied the effect of various thermal methods on pectic compounds in broccoli and they stated that steamed broccoli had greatest firmness and the highest pectic content among all the used treatments. High pectin diet reduces blood glucose level (Stasse- Wolthuis *et al*., 1980; Madhu and Kochhar ,2014).

Table 3. Pectin content in raw and steamed broccoli and cauliflower (on dry weight basis)

Sample	Pectin (%)
Raw broccoli	$27.30^{c}\pm0.13$
Steamed broccoli	$26.10^{d}\pm0.33$
Raw cauliflower	$30.38^{a}\pm0.10$
Steamed cauliflower	$28.70^{b}\pm0.11$

Means followed by the same letter (s) in column are not significantly different at (p≤ 0.05)

Biological assay

Effect of raw and steamed broccoli and cauliflower diets on weight gain, PER and FCE

Table (4) shows the effect of feeding rates on raw and steamed broccoli and cauliflower diets on their weight gain, adjusted protein efficiency ratio (Adj. PER) and fed conversion efficiency (FCE) compared to basal diet. The results indicate that the least weight gain was for the group fed on raw broccoli (50.00 g) followed by the group fed on raw cauliflower (61.67 g) while the highest weight gain was for those who fed on basal diet. The results also show that the steaming process caused an increment in the weight gain of the group fed on steamed broccoli or cauliflower. Moreover the data in Table (4) indicate that the highest value of Adj. PER (2.5) was noticed for the basal diet followed by steamed cauliflower and broccoli being (2.18 and 2.05), respectively. Raw broccoli had the lowest value for Adj. PER (1.63) among all the treatments. The same trend was noticed for feed conversion efficiency (FCE), where raw broccoli and cauliflower exhibited the lowest values for FCE than steamed ones, but the highest value was for the basal diet. The increment in the weight gain, Adj. PER and FCE for steamed vegetables are due to the fact that cooking resulted in an increase in the digestibility of the plant foods (Shekib *et al*., 1992). Obtained results are in agreement with the findings of Alsuhaibani (2013) who found that feeding rats on broccoli powder and aqueous extracts showed significant lower values of body weight and FCE comparing to the basal diet. The results of table (4) indicate that consumption of broccoli or cauliflower could be useful for obesity persons. Soluble or insoluble dietary fibers in plants could help people to stay at healthy weight (Figuerole *et al.,* 2005)

Table 4. Effect of broccoli and cauliflower diets on the PER, adjusted PER and FCE

Food group	Weight gain (g)	PER	Adjusted PER	FCE
Basal diet	$80.00^{a}\pm1.30$	$2.38^{a}\pm0.12$	$2.50^{a}\pm0.04$	$23.80^{a}\pm0.10$
Raw broccoli	$50.00^{e}\pm1.70$	$1.56^{e}\pm0.30$	$1.63^{d}\pm0.07$	$15.65^{e}\pm0.08$
Steamed broccoli	$65.00^{c}\pm1.70$	$1.96^{c}\pm0.12$	$2.05^{b}\pm0.10$	$19.60^{c}\pm0.08$
Raw cauliflower	$61.67^{d}\pm2.10$	$1.85^{d}\pm0.17$	$1.94^{c}\pm0.06$	$18.50^{d}\pm0.11$
Steamed cauliflower	$72.50^{b}\pm1.77$	$2.08^{b}\pm0.09$	$2.18^{b}\pm0.09$	$20.85^{b}\pm0.06$

Means followed by the same letter (s) in column are not significantly different at ($p\leq 0.05$)

Effect of raw and steamed broccoli and cauliflower diets on lipid profile

Table (5) represents the data of total cholesterol (TC) in the serum of rats fed for 40 days on basal diet, raw broccoli, raw cauliflower, steamed broccoli and steamed cauliflower. The results indicate that broccoli and cauliflower diets (raw or steamed) resulted in significant reduction in TC value compared to the basal diet. The decrements were 22.11, 14.42, 25.00 and 24.03%, for raw and steamed broccoli and cauliflower respectively compared to the basal one. Low density lipoprotein cholesterol (LDL- C) and very low density lipoprotein cholesterol (VLDL- C) were also significantly decreased in the blood serum of the rats which were fed on raw and steamed vegetables diets compared to the basal diet. In contrast, the high density lipoprotein cholesterol (HDL-C) increased by 13.33, 23.01% in the blood serum of the rats fed on raw and steamed broccoli and by 15.21, 18.75% for cauliflower diets compared to basal diet. It was found also that TG values were significantly reduced in the blood serum of the rats fed on broccoli or cauliflower diets by 19.09, 26.01, 32,45 and 30.78% for raw and steamed broccoli and cauliflower respectively, compared to the basal diet. These results are in agreement with the findings of Cerda *et al.* (1994) and Jenkins *et al.* (1997), whereas they reported that the lipid risk factor for cardiovascular diseases for healthy volunteers were significantly reduced after 2 weeks of feeding on high vegetable diets including broccoli and cauliflower, in comparison with control diet. They also found that LDL was reduced by 37% for those fed in high vegetable diets. Moreover, Salem *et al.,* (2013) stated that feeding the experimental animals on cauliflower diet caused significantly reduction in the values TC, LDL-C, VLDL-C and TG in the animal's blood serum after 8 weeks of feeding compared to the control group which was fed on basal diet .

Table 5. Total serum cholesterol, cholesterol fractions and triglycerides (mg/dL) of rats[1] fed on broccoli and cauliflower

Food group	Total cholester l (TC)	Reduction %	HDL-C*	Increment %	LDL-C**	Reduction %	VLDL-C***	Reduction %	Triglycerides (TG)	Reduction %
Basal diet	$104.00^{a}\pm2.0$	----	$39.00^{e}\pm0.30$	----	$48.24^{a}\pm2.26$	----	$16.76^{a}\pm0.76$	----	$83.80^{a}\pm2.0$	----
Raw broccoli	$81.00^{c}\pm1.50$	22.11	$45.00^{d}\pm1.25$	13.33	$22.44^{c}\pm1.75$	53.48	$13.56^{b}\pm0.79$	19.09	$67.80^{b}\pm1.80$	19.09
Steamed broccoli	$89.00^{b}\pm1.64$	14.42	$50.66^{a}\pm1.11$	23.01	$25.94^{b}\pm0.45$	46.22	$12.40^{c}\pm0.60$	26.01	$62.00^{c}\pm1.30$	26.01
Raw cauliflower	$78.00^{e}\pm1.50$	25.00	$46.00^{c}\pm0.25$	15.21	$20.68^{d}\pm0.19$	57.13	$11.32^{d}\pm0.20$	32.45	$56.60^{e}\pm0.13$	32.45
Steamed cauliflower	$79.00^{d}\pm1.23$	24.03	$48.00^{b}\pm0.17$	18.75	$19.40^{e}\pm0.17$	59.78	$11.60^{d}\pm0.11$	30.78	$58.00^{d}\pm0.80$	30.78

Means followed by the same letter (s) in column are not significantly different at ($p\leq 0.05$)

1: The result is average of six animals *** HDL-C: High density lipoprotein cholesterol**

**** LDL-C: Low density lipoprotein cholesterol** *****VLDL-C: Very low density lipoprotein cholesterol**

Effect of raw and steamed broccoli and cauliflower diets on serum glucose

Total serum glucose of experimental rates was determined and given in Table (6). The results in the Table show that feeding rats on broccoli or cauliflower diets resulted in significant reduction in their serum blood glucose level compared with the basal diet. The serum blood glucose of the rats fed on basal diet was 90.5 mg/dl and reduced by 20.99 and 12.92 % for the rats fed in raw or steamed broccoli diets, respectively. Also, it reduced by 20.22and 13.65% in the serum blood of those fed on raw or steamed cauliflower. These results are in accordance with those obtained by Rosedale *et al*.(2009) whereas they studied the effect of broccoli and cauliflower diets on human blood serum sugar and they found that fast serum blood glucose value was decreased compared to basal diet. Moreover, Post *et al*. (2012) found a statistically significant improvement in fasting blood glucose when an increase in dietary fiber was used as an intervention in patients with type 2 diabetes mellitus . The biological evaluation were confirmed by the results of Tables (2) and (3) which show that both broccoli and cauliflower (raw and steamed) had high amount of insoluble and soluble dietary fiber which indirectly inhibit both hepatic synthesis of cholesterol fractions and the level of serum blood glucose. So it could be advice to consume broccoli or cauliflower frequently as they are good source of essential nutrients (Mansour *et al.,* 2015[a,b]) and high amounts of dietary fibers (Hanif *et al.,* 2006) . Dietary Reference Intake for Japanese (2010) of dietary fiber (g/day) for children (10-13 yr) is 19-31, for adults male (14-50 yr) is 38, for adult woman (14-50 yr) is 25-26 and 28-29 for pregnant or lactating women.

Table 6. Total serum glucose (mg/dL) of rats[1] fed on broccoli and cauliflower compared to the basal diet

Food group	FBS	Reduction %
Basal diet	$90.50^{a}\pm0.50$	------
Raw broccoli	$71.50^{c}\pm0.70$	20.99
Steamed broccoli	$78.80^{b}\pm0.40$	12.92
Raw cauliflower	$72.20^{c}\pm0.17$	20.22
Steamed cauliflower	$78.14^{b}\pm0.16$	13.65

Means followed by the same letter (s) in column are not significantly different at (p≤ 0.05)
1: The result is average of six animals FBS: Fasting blood sugar

CONCLUSION

From the data in present study it could be concluded that raw and steamed broccoli and cauliflower contained substantial amounts of dietary fiber (soluble or insoluble). Broccoli had higher level of most of the dietary fiber fractions compared to cauliflower. The biological assay rats revealed that addition of raw and steamed broccoli or cauliflower in rats diets could help in loss weight, reducing blood serum TC, LDL-C, VLDL-C, TG and increasing of HDL-C. Also glucose level was reduced.

REFERENCES

Alsuhaibani, A.M.A. (2013). Effect of broccoli on the antioxidant activity of experimental rats ingested thermally oxidized oil. Nature and Science,11: 1-7.

Anderson, J.W.,Baird, P., Davis , R. H. ,Ferreri,S., Knudtson, M. ,Koraym,A., Waters,V and Williams. C.L. (2009).Health benefits of dietary fiber. Nutrition Review, 67:188–205

A.O.A.C. (2003). "Official methods of analysis" 17th ed. Association of official analytical chemists. Washington. DC. Dr. William Horwitz, Editor.

Bourquin, L.D., Titgemeyer, E.C. and Fahey, G.C . (1993). Vegetable fiber fermentation by human fecal bacteria: cell wall polysaccharide disappearance and short-chain fatty acid production during in vitro fermentation and water-holding capacity of confermentresidues. The Journal of Nutrition, 123: 860-869.

Borowski.J., Narwojsz,A., Eulalia,J., Borowska,A.J. and Katarzyna,M.(2015). The effect of thermal processing on sensory properties, texture attributes and pectic changes in broccoli .Czech Journal of Food Sciences ,33: 254–260

Brandt, L.M.,Jeltema, M.A., Zabik, M.E. and Jeltema, B.D. (1984). Effects of cooking in solutions of varying pH on the dietary fiber components of vegetables. Journal of Food Science, 49: 900-904.

Cerda, J.J., Normann,S. J., Sullivan, M. P., Burgin, C. W., Robbins, F. L., Vathada, S., and Leelachaikul.P.(1994).Inhibition of atherosclerosis by dietary pectin in micro swine with sustained hypercholesterolemia. Circulation, 89:1247-1253

Dietary Reference Intake for Japanese (2010). The summary report from the Scientific Committee of Dietary Reference intakes for Japanese. National Institute of Health and Nutrition Depatrment of Nutritional Epidemiology.

Eastwood, M. and Kritchevsky , D. (2005). Dietary fiber: How did we get where we are ?. Annual Review of Nutrition, 25:1-8.

Figuerole, F., Hutado, M.L., Estevez, A.M., Chiffelle, I and Asenjo, F. (2005). Fiber concentration from apple pomace and citrus peel as potential fiber sources for food enrichment. Food Chemistry, 91: 305-401.

Goering, H.K., Van Soest, P.J.(1970) . Forage fiber analysis (apparatus, reagents, procedures and some applications). In: Agric. Handbook No. 379. US Agricultural Research Service, Washington (DC)

Gorinstein, S., Zachwieja, Z., Folta, M., Barton, H., Piotrowicz, J., Zember, M., Weisz, M., Trakhtenberg, S., and Mart_ın-Belloso, O. (2001). Comparative content of dietary fiber, total phenolics, and minerals in persimmons and apples. Journal of Agricultural and Food Chemistry, 49: 952–957.

Grigelmo-Miguel, N., Gorinstein, S., and Mart_in-Belloso, O. (1999).Characterization of peach dietary fiber concentrate as a food ingredient. Food Chemistry, 65: 175–181.

Hanif, R., Iqbal, Z., Iqbal, M., Hanif, S. and Rasheed, M. (2006). Use of vegetables as nutritional food: role in human health. Journal of Agricultural and Biological Science,1: 18-22.

Jenkins, D.J.A, Leeds, A.R., Gassul. M. A. Wolever, T.M.S. , Goff, D.V. , Albert, K.G.M.M. and Hochady, T.D.R. (1976). Insoluble carbohydrates and diabetes: decreased postprandial hyperglycemia. The Lancet, 2:172.

Jenkins,R , Lewis,G, Bebbington, P, Brugha, T, farrell,M, Gill,B and Meltzer, H.(1997). The national psychiatric morbidity surveys of great Britain - initial findings from the household Survey. Psychological Medicine, 27: 775-789.

Kahlon, T.S., Chiu, M.M. and Chapman, M.H. (2008). Steam cooking significantly improves in vitro bile acid binding of collard greens, kale, mustard greens, broccoli, green bell pepper, and cabbage. Nutrition Research, 28 : 351-357.

Kiehm,T.G., Anderson, I. Wand Ward, K.(1976). Beneficial effect of high carbohydrate, high fiber diet on hyperglycemic diabetic men. The American Journal of Clinical Nutrition, 96:895

Madhu and Kochhar, A. (2014). Proximate composition, available carbohydrates, dietary fiber and anti-nutritional factors of Broccoli (Brassica oleracea L. Var. Italica Plenck) leaf and floret powder. Bioscience Discovery, 5:45-49.

Mansour, A.A.; Elshimy, N. M.; Shekib, L. A and Sharara, M.S. (2015)a Comparative study between the bioactive compounds and antioxidant activity of broccoli and cauliflower and the effect of domestic processing on them. The International Journal of Science & Technoledge, 3: 246-254

Mansour, A.A.; Elshimy,N.M.; Shekib,L.A and Sharara, M.S. (2015)b Effect of domestic processing methods on the chemical composition and organoleptic properties of broccoli and cauliflower. American Journal of Food and Nutrition, 3: 125-130.

Mukherjee, V. and Mishra, P.K. (2012). Broccoli-an underexploited neutraceutical. Science Research Reporter, 2: 291-294.

Ndome, C.B., Ekwu, A.O. and Ateb, A.A. (2011). Effect of feeding frequency on feed consumption, growth and feed conversion of *Clarias gariepinus* ♂ X *Heterobranchus longifilis* ♀ hybrids. American-Eurasian Journal of Scientific Research, 6: 6-12.

Pereira,M.A. and Pins,J.J. (2000). Dietary fiber and cardiovascular disease: experimental and epidemiologic advances. Current Atherosclerosis Reports,2:494-502.

Post, R.E., Mainous, A,G., King, D.E. and Simpson, K.N. (2012).Dietary fiber for the treatment of type 2 diabetes mellitus:Meta-Analysis. Journal of American Board of Family Medicin, 25: 1-16.

Pellet, P.I. and Young, V.R. (1980). Nutritional evaluation of protein foods. The United Nation's University Hunger Programme. Food and Nutrition Bulletin, Suppl. 4, The United University, Tokyo.pp. 129

Ranganna, S. (1977). Mannuals of Analysis of Fruits and Vegetable Products. Tata McGraw Hill Publishing Co., New Delhi.

Rosedale, R., Westman, E.C. and Konhilas, J.P. (2009). Clinical experience of a diet designed to reduce aging. The Journal of Applied Research, 9: 159-165.

Salem, A.A., Mohammed, F. and Alloush, S.A. (2013). Nutritional impact of cauliflower and broccoli against development of early vascular lesions induced by animal fat diet (biochemical and immunohistochemical studies). Life Science Journal, 10: 2496- 2509.

Shekib, L.; El-Shimi, N. and El-Khodary, L. (1992). Effect of dehulling and cooking processes on the nutritional quality of some Egyptian legume seeds. Journal of the Medical Research Institute, 13: 109-122.

Sila, D.N.; Van Buggenhout,S.; Duvetter, T.; Fraeye,I; De Roeck, A.; Van Loey,A. and Hendrickx,M. (2009).Pectins in processed fruits and vegetables: Part II— Structure– function relationships. Comprehensive Reviews in Food Science and Food Safety, 8:86-103.

Stasse-Wolthuis, M., Albers, H. F., van Jeveren, J. G., Wil de Jong, J., Hautvast, J. G., Hermus, R. J., Katan, M. B., Brydon, W. G., and Eastwood, M. A. (1980). Influence of dietary fiber from vegetables and fruits, bran or citrus pectin on serum lipids, fecal lipids, and colonic function. The American Journal of Clinical Nutrition, 33 :1745-1756

Steel, R.G. and Torrie, J.H. (1980). Principles and Procedures of Statistics. A Biometrical Approach. 2 nd ed., Mc grawhill co., Inc. USA.

SYNCHRON LX system chemistry information manual 962288.2000. BeckmanCoulter, Inc.

Thebaudin, J. Y., Lefebvre, A. C., Harrington, M., and Bourgeois, C. M. (1997). Dietary fibres: Nutritional and technology interest. Trends in Food Science and Technology, 8: 41–48.

Trinder, P. (1969). Determination of glucose in blood using glucose oxidase with an alternative oxygen acceptor . Annals of Clinical Biochemistry , 6: 24-27.

Van Soest, P.J.(1973). Collaborative study of acid detergent fiber and lignin. Journal - Association of Official Analytical Chemists ,56: 781–784.

Van Soest P.J., Robertson, J.B . and Lewis, B.A.(1991). Methods for dietary fiber, neutral detergent fiber, and non-starch polysaccharides in relation to animal nutrition. Journal of Dairy Science, 74, 3583-3597.

Weickert, M.O. and Pfeiffer, A.F.H. (2008). Metabolic effects of dietary fiber consumption and prevention of diabetes. The Journal of Nutrition, 138: 3:439-442.

التقييم الحيوى لكل من البروكلي و القنبيط الخام و الملسوق بالبخار كمصادر للألياف الخام

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أجريت الدراسة بهدف تقدير الالياف الغذائيه لكل من القنبيط و البروكلى الخام و المسلوق بالبخار لمده 12 دقيقه كما تم تغذيه فئران التجارب على وجبات تحتوى عليهما لدراسة تأثير ذلك على كل من كفاءة استخدام البروتين PER معدل زياده الوزن و كفاءه تحويل الغذاء FCE وايضا محتوى الدم من الكوليستيرول الكلى TC و الجليسريدات الثلاثيه TG وكذلك الليبوبروتين منخفض الكثافه LDL-C والليبوبروتين عالى الكثافه HDL-C و أخيرا محتوى السكر فى الدم ومقارنتها مع الفئران التى تم تغذيتها على الوجبه القياسية . ولقد أوضحت النتائج احتواء االبروكلى الخام على نسبه عاليه من الألياف المتعادلة NDF والألياف الحامضيه ADF (37,64 ٪ و 31,99 ٪) بالمقارنه بالقنبيط الخام الذى احتوى على 32,7٪ و 26,71٪ من كلا من نوعى الالياف الغذائيه على التوالى بينما لم تظهر النتائج اى فروق معنويه فى محتوى اللجنين الحامضى ADL و الهيميسليولوز فى كل من القنبيط و البروكلى الخام . محتوى السليولوز كان أعلى فى كل من البروكلى الخام و المسلوق بالبخار (15,96٪ و10,59٪) بالمقارنه بالقنبيط الخام و المسلوق بالبخار (9,82 ٪ و 8,48٪) احتوى كل من البروكلى و القنبيط الخام على نسبه بكتين 27,3 ٪ و 30,38 ٪ على التوالى. أدت عمليه السلق بالبخار لمده 12 دقيقه الى انخفاض معنوى محدود فى محتوى الالياف الغذائيه لكل من البروكلى و القنبيط . تغذيه فئران التجارب على وجبات معده من كل من البروكلى و القنبيط الخام أدت الى انخفاض نسبه الزياده فى الوزن بالمقارنه بالفئران التى تمت تغذيتها على الوجبه القياسية حيث كانت الزياده فى الوزن هى 50جم ، جم 61,67 عند التغذيه على البروكلى و القنبيط الخام بينما كانت الزياده فى الوزن عند التغذيه على البروكلى و القنبيط المسلوق 65 جم و 72,5 جم على التوالى و كانت الزياده فى وزن فئرات التجارب التى تم تغذيها على الوجبه القياسيه هى 80 جم. كما أظهرت النتائج ايضا ان تغذيه فئران التجارب على وجبات محتويه على البر وكلى و القنبيط الخام و المسلوق لمده 40 يوم أدت الى تخفيض من كل من TC, LDL-C, VLDL-C, HDL-C,TG بينما زادت من HDL-C . انخفضت نسبه الجلوكوز فى الدم بنسبه 20,99٪ و 12,92٪ و20,22٪ و 13,65٪ فى الفئران التى تم تغذيتها على البروكلى و القنبيط الخام و المسلوق على التوالى هذا بالمقارنه بمجموعه الفئران التى تم تغذيتها على الوجبه القياسيه.