PJN

ISSN 1680-5194

PAKISTAN JOURNAL OF NUTRITION

ANSInet
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Pakistan Journal of Nutrition 9 (10): 987-989, 2010
ISSN 1680-5194

Taurocholate Binding Capacity and Water Holding Capacity of Some Wild Leafy Vegetables of Northern Nigeria

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Abstract: Taurocholate binding capacity (TBC) and water holding capacity (WHC) of twelve wild leafy vegetables commonly consumed in northern Nigeria were studied. Taurocholate binding capacity varied between 17.36±2.58 to 31.02±1.21mg/g. Results obtained showed that Celtis africana had the highest taurocholate binding value of 31.02±1.21 mg/g followed by Hibiscus cannabimis (30.02±1.23) and Balanite aegyptiaca (30.12±3.23mg/g). The lowest taurocholate binding capacity value was observed in Apuim gravealens (21.73±0.25mg/g). While the highest water holding capacity value was observed in Celtis africana (2.24±0.28mg/g), closely followed by Balanite aegyptiaca (2.08±0.11mg/g) and Moringa oleifera (1.88±0.13mg/g). Corchorus oloitoms, Solanium nigrum and Mormodica basalmina had the lowest water holding capacity value (1.02±0.04, 1.21±0.01 and 1.27±0.05mg/g respectively). Thus indicating that these wild vegetables contain high fiber and have the potential to reduce cholesterol considerably from the body and other related diseases.

Key words: Taurocholate binding capacity, water holding capacity, wild vegetables, cholesterol, fiber

INTRODUCTION

The end product of cholesterol metabolism is a primary bile acid known as taurocholate. It is excreted from the body through feaces as neutral steroid of bile acid (Murray *et al*., 1988). Synthesis of bile acid is one of the predominant mechanisms for the excretion of excess cholesterol from the body. However the excretion of cholesterol in the form of bile acids is insufficient to compensate for an excess dietary intake of cholesterol (Michael, 2006). Elevated level of cholesterol in the body causes hypercholesterolemia, which occurs jointly with other disorders associated with lipid metabolism (Murray *et al*., 1988). These diseases or disorders affect middle age sedentary people and tend to occur in combination of two or three in the same individual (Umaru *et al*., 2003). These include arteriosclerosis, colorectal cancer, xanthomatosis, angina, coronary artery diseases etc (Ruales and Nair ,1994). Efforts have been directed to reduce the levels of cholesterol in the hope of reducing the degree of vascular cholesterol deposition. However, some of the drugs used to reduce cholesterol to a minimum level are harmful and have some complications (Lopez, 2002) some cholesterol lowering drugs have their side effects ranging from liver damage, muscle tenderness, weakness, to intestinal problem (Tracy, 2004).

Fiber has the ability to hold water and bind with cholesterol. Absorption of cholesterol is interrupted by dietary fiber in the small intestine, thus minimizing the rate of cholesterol absorption thereby decreasing the rate of lipid absorption (Umaru *et al*., 2003). The product of cholesterol metabolism (bile acid salts) bind with fiber complexes that are not absorbed and are excreted with feaces (Johnson, 1990). Short chain fatty acids, which are products of fermentation from soluble fiber in the gut, may inhibit synthesis of cholesterol by the liver thereby reducing the concentration of blood cholesterol (Truswell, 1990). Dietary fiber also removes health harm full factors such as artificial food, aluminium and mutagens from the body and improves the flora of intestinal bacteria (Lopez, 2002). The high viscosity of soluble fiber may also slow the rate of digestion and absorption of carbohydrate, affecting insulin activity, which is implicated in the removal of LDL-cholesterol (Truswell, 1999).

Wild vegetables are commonly consumed in northern Nigeria. Little is however known about their fiber content. This study was therefore undertaken to determine the taurocholate and water holding capacity of twelve wild leafy vegetables commonly consumed in northern Nigeria.

MATERIALS AND METHODS

Collection and treatment of samples Wild vegetables were obtained around the Federal University of Technology Yola in May, 2005. Plant materials were dried under room temperature and ground to powder using mortar and pestle. Ground materials were sieved using 1mm sieve.

Taurocholate binding capacity determination: To different weight of the samples (2.0, 1.0, and 0.5g),

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Table 1: Taurocholate binding capacities of varieties of wild g leafy vegetables (mg/g)

Vegetable	2g	1g	0.5g
Colocasia esculentus (Taro)	29.24±3.21	23.50±0.51	17.33±0.70[f]
Balanite aegyptiaca (Addua)	30.12±3.25[a]	22.51±0.05	18.64±1.67[f]
Moringa oleifera (Zogale)	29.45±0.50	25.43±2.01	23.22±0.48
Celtis africana (Zuwo)	31.02±1.21[a]	29.16±1.81[c]	6.10±0.13[e]
Apium gravealens (Karkashi)	21.73±0.25[b]	19.48±0.03[d]	17.36±2.58[f]
Hibiscus cannabimis (Rama)	30.60±1.23[a]	23.45±2.43	18.83±0.46[f]
Corchorus olitorius (Lalo)	29.67±0.85	27.39±1.42	25.08±0.72[e]
Mormodica basalmina (Grahuna)	26.95±2.26[b]	24.23±0.80	20.67±1.03
Hibiscus esculentus-bush (Kubewa)	29.63±0.09	27.72±1.37	22.37±1.53
Solanum nigrum (Kumbi)	27.33±0.06[b]	26.90±0.12	22.19±0.07
Cassia tora (tafassa)	29.15±1.38	26.49±3.05	21.80±0.20
Leptadenia histata (Yadiya)	23.01±3.0[b]	21.82±0.05	20.76±2.21
Pectin (Standard)	32.08±0.12	31.30±0.01	31.20±0.08

Results are mean ± SD for three (3) determinations.

a = significantly higher compared with Apium gravealens, Mormodica basalmina, Solanium nigrum and Leptadenia histata under 2g ($p < 0.05$). b = significantly lower compared with other vegetables under 2g ($p < 0.05$). c = significantly higher compared with other vegetables under 1g ($p < 0.05$). d = significantly lower compared with other vegetables under 1g ($p < 0.05$). e = significantly higher compared with other vegetables under 0.5g ($p < 0.05$). f = significantly lower compared with other vegetables under 0.5g ($p < 0.05$)

Table 2: Water holding capacities of varieties of wild leafy vegetables (mg/g)

Vegetables	2g	1g	0.5g
Colocasia esculentus (Taro)	1.66±0.04	0.64±0.13	0.47±0.08
Balanite aegyptiaca (Addua)	2.08±0.11[a]	1.05±0.15	0.97±0.01[c]
Moringa oleifera (Zogale)	1.88±0.13	1.15±0.19	0.57±0.07
Celtis africana (Zuwo)	2.24±0.28[a]	2.06±0.05[b]	0.50±0.05
Apium gravealens (Karkashi)	1.32±0.02	0.91±0.14	0.62±0.06
Hibiscus cannabimis (Rama)	1.67±0.03	0.97±0.07	0.65±0.03
Corchorus olitorius (Lalo)	1.02±0.04	1.05±0.21	0.65±0.08
Mormodica basalmina (Grahuna)	1.27±0.05	0.56±0.07	0.44±0.02
Hibiscus esculentus-bush (Kubewa)	1.61±0.03	0.67±0.09	0.40±0.08
Solanum nigrum (Kumbi)	1.21±0.01	0.77±0.05	0.54±0.03
Cassia tora (tafassa)	1.49±0.02	1.17±0.10	0.56±0.07
Leptadenia histata (Yadiya)	1.57±0.09	0.79±0.09	0.58±0.02
Pectin (Standard)	1.98±0.04	1.89±0.02	0.82±0.01

Results are mean ± SD for three (3) determinations.

a = significantly higher compared with other vegetables under 2g ($p < 0.05$). b = significantly higher compared with other vegetables under 1g ($p < 0.05$). c = significantly higher compared with other vegetables under 0.5g ($p < 0.05$)

10mls of water was added and allowed to boil for 5 minutes. The suspension was then filtered through Whatman (No. 1) filter paper. Samples were then washed thrice with 10ml ethanol each time followed by centrifugation at 2400rpm, the supernatant was discarded and the residue air-dried for subsequent use. Samples were then put into a dialyzing tube and kept in a refrigerator at 4^o over night. Twelve test tubes were used for the test. To the test tube labelled blank, 1ml of water, 0.5ml of sucrose solution and 1ml of conc. H_2SO_4 was added drop wise from the biuret. To the eleven test tubes, 1ml of taurocholate, 0.5ml water and 0.5ml sucrose was added to each followed by drop wise addition of 1ml H_2SO_4 from the biuret. Taurocholate concentration was calculated using Lambert-Beers equation.

Water holding capacity determination

Procedure: Water holding capacity was determined according to the method of McConnell and Eastwood (1974). Different weight (2.0, 1.0 and 0.5g) of the powdered sample was soaked in water for 24hours. It was then centrifuged at 2400rpm to remove the interstitial water. The water holding capacity was calculated from the difference in weight of material before and after centrifugation.

RESULTS AND DISCUSSION

Results of taurocholate binding capacity are as shown in Table 1. Results obtained showed that Celtis africana had the highest taurocholate value of 31.0±1.2 mg/g, closely followed by Hibiscus cannabimis (30.60±1.23mg/g) and Balanite aegyptiaca (30.12±3.25mg/g). The high values indicate that these plants have the potential to reduce cholesterol. Hence they can be consumed freely especially by individuals with cholesterol related diseases since fibers are known to bind cholesterol in the body thereby increasing feacal weight, reduce transit time, decrease glucose and cholesterol level in the blood and reduce the risk of colon cancer (Truswell 1990; Kritchevsky, 1997). However it was shown that the degree of bile acids adsorption depends on the kind of raw material and the type of bile acids. According to (Umaru *et al*., 2003), there is a correlation between the taurocholate binding capacity and water holding capacity. Several epidemiological studies have shown that the faecal bile acids especially the secondary bile acids are higher in population that consume higher-fat and lower fiber diet (Owen *et al.*, 1986). If there is sufficient fiber in the diet, bile acids moving along the intestine may be broken back down into cholesterol and reabsorbed into the blood (Anderson *et al.*, 1990). Fiber may also block the absorption of fat from the digestive tract and reduce cholesterol synthesis in the liver (Kesanniemi *et al.*, 1990; Anderson, 1987). Results obtained in Table 1 showed that some of these wild plants could compute favorably with standard pectin used. Pectin has been shown to reduce cholesterol level (AHS, 1998 and LSRO, 1987). The water holding capacity values ranged from 2.24±0.28mg/g in Celtis africana to 1.02±0.04mg/g in Corchorus oloitoms. The water holding capacity of dietary fiber is thought to be an important factor of faecal bulking and intestinal transit which influence gastrointestinal disease (Suzuki *et al.*, 1996; Biekett *et al.*, 1997). This suggests that hydrogen bond and hydrophobic interaction mediated in the binding of taurocholate to alcohol insoluble solids. Variations in taurocholate binding capacity values were based on the variation in water holding capacity values. However other physiochemical factors other than water holding capacity may be responsible for the variation in taurocholate binding capacity values. Values obtained for taurocholate binding capacity and water holding capacity of the leafy vegetables for 2g, 1g, and 0.5g were significant at $p< 0.05$. However binding increases with increase in concentration of food sample in the order of 0.5g> 1.0g> 2.0g. All the wild leafy vegetables had the ability to hold water and bind to bile acids *in vitro* and the capacity depends on the tendency to imbibe water. It therefore shows that if 450g of Celtis africana is consumed for a period of three months based on the average consumption of 5g/day/individual, it will be able to extract 45g of taurocholate from enterohepatic circulation, which will bind to equal amount of cholesterol and pass out in faeces, leading to a hypocholesterolemic effect. If intended as a drug, the natural intake of 5g could be doubled to 10g and the duration of application in turn reduced since these plants are consumed freely in the study area with no cultural restriction.

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