Research article Available online www.ijsrr.org ISSN: 2279–0543

International Journal of Scientific Research and Reviews

Charakokta Pathyanna For Prameha: The Functional Food For Diabetes

Priyadarshi Apurva[1] and Singh Sadhana[2]

[1]PhD scholar, Department of Dravyaguna, I.M.S, B.H.U, Varanasi, Uttar Pradesh, India.
[2]Senior Resident, Department of Dravyaguna, I.M.S, B.H.U, Varanasi, Uttar Pradesh, India.

ABSTRACT

In Ayurveda the man is considered to be made and nourished by the Anna. The Prana is carried and maintained in livings by the Anna so the world bows before its importance. The Varna (body color), Prasad (lusture), Sauswarya (proper speech), Pratibha (wisdom), medha (memory and intellect), Tushti (feel of satisfaction), and Sukha (pleasure) all remain present in Anna which reflects in man after its proper intake.these body nourishing intake of anna is said to be pathya. Nowadays the concept of functional food is getting stronger. Acharya charak has mentioned almost same concept of anna for several diseases. It varies by the type and condition of disease conditions. In this paper the scientific evaluation of anna mentioned by Charak in Prameha has been presented on the basis of modern scientific works done in the name of functional food.

KEYWORDS: *Pathya, Ayurvedic,Prameha, Anna ,Functional food, Dravya*

[2]Corresponding Address

Dr. sadhana singh

Dravyaguna department, IMS BHU VARANASI, UP

221005

E Mail ID - drsadhana085@gmail.com

INTRODUCTION

In the primary health care the plants are of great importance. Ayurveda describes about the medicinal values and uses of plants for healthcare since first time. These dravya are divided into two categories *Ahar dravya* and *Aushadh dravya*. *Ahar dravya* are those which we take to maintain the natural status, physiology of body. These are considered as the dravya which perform their role on the basis of Rasa. The second category of dravya is considered to play their role on the basis of *Veerya* (potency). These dravya are used when the body gets compromised with healthy status i.e. get diseased. Anna (grains) come under the first category i.e. Ahar dravya.

In Ayurveda the man is considered to be made and nourished by the Anna. The Prana is carried and maintained in living by the Anna so the world bows before its importance. The Varna (body color), Prasad (lusture), Sauswarya (proper speech), Pratibha (wisdom), medha (memory and intellect), Tushti (feel of satisfaction), and Sukha (pleasure) all remain present in Anna which reflects in man after its proper intake. Hence it can be said each component of body is made of Anna indirectly. Achary kashyap has emphasized on the importance of anna by saying that ahar is Mahabhaishajya. It means that the bhaishjya (medicine) performes their therapeutic action in that body which is mainly constructed on the basis of ahar (anna). Without which the desired benefits of bhaishajya cannot be even assumed. The ahar (anna) provides a base for life and lifegoing processess hence also for bhaishajya (medicines) to act upon. This is the cause which gives the ahar (anna) an upper hand over *Bhaishajya* hence termed as *Mahabhaishajya*.

The Ahar, Anna which keeps the body channels healthy, in natural status is called pathya[2] .The concept of functional food looks alike.

FUNCTIONAL FOOD

Functional foods are foods that have a potentially positive effect on health beyond basic nutrition. Proponents of functional foods say they promote optimal health and help reduce the risk of disease.

Beyond meeting the basic nutritional needs when an additional physiological benefit is provided by food material then it makes them a Functional food. Defining the functional food the institute of medicine food and nutrition board stated that any food or its ingradient which may provide a health benefit beyond its traditional nutrients may be considered as functional food. In 1992 Block et al showed the relation between people consuming fruits and vegetables high diet and lowered cancer risk on the basis of a review of 200 epidemiological studies.[3]

PATHYA ANNA MENTIONED BY CHARAKA

Acharya charak has mentioned several annapaana to practice in order to fight against prameha in diseased condition. He also refers some anna which on regular intake prevents the occurrence of Prameha (Diabetes), Svitra(Leucoderma) and kaphaja Kustha(Leprosy).[4]He stated that in the condition of Prameha the food materials which pacifies the vata , minimizes the shleshma and meda should be used. He adds to it that use of the powder of Yava (Hordeum vulgare) and amalki (Emblica officinalis) is one of the best regimens. He also ascribed Prashatika, Priyanguka (*Setaria italica*), Shyamak(*Echinochloa frumentacea*) Yavaka (*Avena Sativa* Linn.), Yava(*Hordeum vulgare*) , Joornaahva(*Sorghum vulgare* Pers), kodrava (*Paspalum scrobiculatum*) mudga *(Vigna radiata*), kulattha(*Dolichos biflorus*), chakramudgaka, aadhaki beeja(*Cajanus indicus* spreng) for the eradication of obesity and Prameha.[5]

INSIGHTS AS FUNCTIONAL FOOD

Priyanguka (Setaria italica L.)

It is also called foxtail millet. Kangu and kanguni are the popular names. It has guru, Ruksha property with vata vitiating and kapha minimizing effect. It is specially recommended in fractures of bone[6]. Due to its high fibre content it is recommended in diabetic patients in india.experimentally it has been proven to be beneficial for diabetics. Setaria italica aqueous extract at the dose of 300 mg /kg b.w. was found to reduce the blood glucose by 70% in diabetic rats after 6 hrs of administration.in the mean time No any change in blood glucose levels of normal rats observed. A significant decrease in FBS +significant improvement in glycemic control(HbA1c) in diabetic treated rats has also been observed . It is a grain with excellent antihyperglycemic and hypolipidemic activities of the aqueous extract which could be due to the presence of alkaloids or glycosides as active principles.[7]

Lee et al concluded that by reducing plasma triglycerides in hyperlipidaemic rats the foxtail millet may prevent from cardiovascular diseases[8]

Shyamak(Echinocloa colona)

It is known as Indian barnyard millet, sawa millet. Most popularly called "Sava ka chawal" in hindi and "Vari cha Tandul" in Marathi as the seeds of this grass is used to prepare various dishes and consumed during festival fasting days.

The shyamak has shoshan (kapha and water absorbing) and Ruksha properties hence increases the vata and pacifies the Shleshma and pitta.[9] its properties also resembles with the kodrava.

The protein content has been found higher and lysine content lower, when compared to major millets. Dehusked millets had lower total dietary fibre (TDF) and tannin. The true digestability (TD), of protein ranged between 95.0 to 99.3, whereas the biological value (BV), was between 48.3 and 56.5. This is poor sources of calcium, phosphorus and iron.[10]The action of millet proteinase inhibitors on human and other animal pancreatic enzymes has been detailed. The role of substrates in determining the magnitude of the inhibition of proteolytic enzymes by the millet inhibitors is emphasized.[11] Next to cereals; millets are the primary sources of energy in the semi-arid tropics and drought-prone regions of Asia and Africa. Millets are nutritionally superior as their grains contain high amount of proteins, essential amino acids, minerals, and vitamins.[12]

Yavaka (Avena Sativa Linn.)

it is known as jai or tokya in Ayurveda.[13] It seems to be the variety of yava. The suffix "ka" in word "yava" (yava + **ka**) means that though it is veriety of yava but of inferior in size or quality.

It is a pseudocereal known as common oat. It has got very important role nowadays in the weight mangment as well as a diet source for diabetics. Consumption of this food reduces the LDL, cholesterol and thereby reduces the risk of coronary heart diseases. Due to this the FDA awarded the first food specific health claim in 1997 to a Quaker oats company.[3]

It has also been assumed that the soluble fiber of oat gets mixed with water and it forms a gummy barrier between digestive enzymes in the stomach and the starch molecules of the diet. Hence it lingers the duration of conversion of the diet's carbohydrate into blood sugar.

Yava (Hordeum vulgare)

It is a member of gramineae family commonly known as Barley. yava is dehusked to make barley whereas the sprouted yava is used for preparation of malt. The flour made of yava is highly recommended in several disease conditions. Its saktuk (powder of dry roasted yava) is highly recommended to consume in obesity. The diet proponent with yava is used in Prameha (Diabetes) and sthaulya (obesity). It is clearly mentioned by Acharya Charak that the person who takes a regular diet having roasted Yava and saktuk will never suffer from Prameha (Diabetes).[4]

It is said to have madhura- kashaya rasa and Ruksha, slight guru guna with sheeta Veerya (cool effect). It aggrevates Vata, pacifies Kapha, having stool increasing and strengthening property[13]. It promotes the satva guna also.

The modern scientific studies also prove it to be very beneficial as antidiabetic diet.

A significant fall in both plasma total cholesterol (6%, P less than 0.05) and in LDL cholesterol (7%) has been observed in association with Consumption of barley relative to wheat foods. It has been concluded that barley dietary fiber is more effective than wheat dietary fiber at lowering blood cholesterol in hypercholesterolemic men.[14]

Sprouts of barley (*Hordeum vulgare* L.), is a good source of beneficial phenolic bioactives. These cereal sprouts contain health relevant phenolic bioactives which can be targeted to manage oxidative stress commonly associated with type 2 diabetes (T2D) in chronic hyperglycemia [15]

Dietary fibre may benefit in improving the blood glucose response in long term. Nowadays the lower glycaemic index (GI) and higher dietry fibre content are the main cause of worldwide interest in barley.[16]

In an experimental study a reduction in weight gain and also in hepatic lipid accumulation, with improved insulin sensitivity in mice fed a high-fat diet has been observed while there was an increase of 4% in barley beta glucan BG induced. Insulin signaling enhanced due to the expression changes of glucose and lipid metabolism genes by BG consumption. For preventing obesity, insulin resistance, and the metabolic syndrome Consumption of barley BG can be an effective strategy.[17]

Intake of Barley reduces the rise in blood sugar by almost 70% and keeps it lower and steadier for hours in comparison to intake of white rice. The probable cause behind this may be due to the soluble fiber and other compounds in barley may slow down the digestion and absorption of carbohydrate.

Joornahva (Sorghum vulgare Pers syn sorghum bicolor.)

It is commonly called **sorghum** and **great millet**, also called jwaar,jowari, jinaura in hindi. It is basically the Joornahva and Yavnaal mentioned in Ayurveda . it is sweet in taste. It pacifies the vaata and kapha dosh and counteracts the medodosha (obesity).[18] It is specifically indicated in Prameha (Diabetes) [19].

Sorghums, has been found to perform the antioxidant activity. The phenol content of the sosorghum has been correlated with this activity. All the phenolic measurement confirmed through three methods i.e. ABTS, DPPH and ORAC (oxygen radical absorbance capacity) [20]

Hargrove et al concluded that potential health benefits of sorghum bran may include actions of monomeric flavanoids as well as proanthocyanidins.[21]

Colonic effects of extruded whole-grain sorghum diets were evaluated using a model of growing rats. Consumption of sorghum diets showed satiety properties, with reduction of caecal pH, and lower activity of β-glucosidase and β-glucuronidase enzymes. It is likely that despite the extrusion the low bioavailability of the phenolic compounds of sorghum diets caused them to exert mainly acute effects at the colon level. Extruded whole-grain sorghum is a good functional ingredient that might be promising in dietary prevention of intestinal diseases.[22]

Kim et al concluded from his study that the cholesterol-lowering effect of Sorghum extract may be related to the regulation of hepatic cholesterol metabolism in this mouse model.[23]

Nguyen et al (2014) isolated the twelve flavonoid glycosides 1-12. Out of them the copounds 3,4,7,9 and 10 possessed strong inhibitory effects on α-glucosidase enzyme, as compared to acarbose as positive control. Study concludes that the flavonoid enriched extract of s. bicolor may be considered as functional food having beneficial effects against diabetes, blood coagulation induced ischaemia and thromboembolism. [24]

Aguerre et al (2015) suggested that sorghum grain supplementation of animals in positive energy balance (cattle and sheep) fed a fresh temperate pasture modifies the hepatic metabolism to prioritize the use of propionate as a gluconeogenic precursor[25]

Kodrava –(Paspalum scrobiculatum – Linn)

In India, kodo millet is ground into flour and used to make pudding. It is known as Kodrava and Koradusha in Ayurvedic texts. It is considered as grahi having sheeta Veerya.it aggrevates the Vata dosha but pacifies Pitta and kapha both.[26] It is a nutritious grain and a good substitute to rice or wheat. Containing 11% of protein, It provides good amount of fibre at 10 grams (37-38%), whereas rice (0.2/100 g), and wheat, (1.2/100g) couldnot provide so. An adequate amount of fibre source helps in counteracting the feel of hunger.

When screened for free radical quenching of 1,1, Diphenyl-2-picrylhydrazyl (DPPH) by electron spin resonance (ESR) the Methanol extracts of the kodo millet flour showed 70% DPPH quenching in comparison to other millets. Kodo millet had the highest DPPH quenching activity followed by great millet and finger millet. Fractionation of kodo millet in to husk and endosperm also decreased the activity and the phytochemicals appear to act synergistically.[27]

In order to evaluate the antidiabetic activity of aquaeous and ethanolic extracts of *Paspalum scrobiculatum* Linn. (Poaceae) in alloxan induced diabetic rats a study was carried by Jain et al 2009. These extracts were orally administered at the doses of 250 and 500 mg/kg bw. Extract exhibited a dose dependant fall in fasting blood glucose. Ethanolic extract at 500 mg/kg dose

exhibited maximum reduction in FBG (35.14%) after 15 days of treatment. Increase in serum insulin,significant increase in liver glycogen with loss of body weight and decrease in glycated haemoglobin levels were observed. This study confirms the traditional claim as Acharya Charak advised for its use in Prameha (Diabetes) [28]

Kulattha (Dolichos biflorus)

It is known as kulattha in Ayurvedic texts. It has kashay rasa, Ushna Veerya and katu vipaka as its specific character. It pacifies the Kapha and vaat dosh, aggrevates amlapitta.[29]

In order to evaluate the antidiabetic activity of *Dolichos biflorus* the study was carried out on STZ induced diabetic rats. Diabetic rats received *Dolichos biflorus* in single dose of 300 mg/kg body weight/day intra-gastrically per day for 30 days. FBS levels were assessed on 1st, 8th, 15th, 22nd and 30th day. On last day the lipid profile, pancreatic tissue histology was done. FBS levels were decreased significantly with decreased S cholesterol and S. triglyceride levels significantly It was concluded that *Dolichos biflorus* has anti-diabetic and anti-lipidemic effect at daily oral dose and can be used as an adjuvant for management of diabetes mellitus and its associated complications.[30]

Atasi (Linum usitatissimum Linn.)

It is also known as **common flax** or **linseed**. In Ayurvedic texts it is described in the name of Uma, Atasi. It has madhura and tikta rasa, snigdha guna katu vipaka and ushna Veerya. It pacifies the kapha ,pitta and vata.[31]

Among the pramehaghna (antidiabetic) oil bearing grains acharya Charak has given it the foremost place. It was his keen observation that is being accepted worldwide even nowadays. Modern scientific researchers are justifying his verses.

Among the major seed oils, flaxseed oil contains the most (57%) of the omega-3 fatty acid, a-linolenic acid.Recent research, however, focuses on fiber-associated compounds known as lignans. According to *Setchell et al.*, (1981) the two primary mammalian lignans, enterodiol and its oxidation product, enterolactone, are formed in the intestinal tract by bacterial action on plant lignan precursors. The richest source of mammalian lignan precursors is Flaxseed (*Thompson et al*., 1991). Because enterodiol and enterolactone are structurally similar to both naturally-occurring and synthetic estrogens, and have been shown to possess weakly estrogenic and antiestrogenic activities, they may play a role in the prevention of estrogendependent cancers. [3.]

Adolphe *et al* (2010) has discussed in his review about the potential health benefits of lignin SDG (secoisolariciresinol diglucoside) found in the Flaxseed. By reducing lipid and glucose concentrations, decreasing oxidative stress, inflammation and lowering blood pressure, SDG

metabolites may protect against CVD and the metabolic syndrome. Flax lignans may also reduce cancer risk by preventing pre-cancerous cellular changes and by reducing angiogenesis and metastasis. After ingestion, SDG is converted to secoisolariciresinol, which is further metabolised to the mammalian lignans enterodiol and enterolactone. [32]

In another randomized clinical trial Patients were supplied with flaxseed-derived lignan capsules (360 mg lignan per day) or placebo for 12 weeks, separated by an 8-week wash-out period. HbA1c, lipid profiles, insulin resistance index and inflammatory factors were measured. The lignan supplement significantly improved glycemic control HbA(1c) compared to placebo. But no significant changes were observed in insulin resistance, blood lipid profiles, fasting glucose and insulin concentrations.[33]Flaxseed mucilage improves insulin sensitivity and alters the gut microbiota; however, the improvement in insulin sensitivity is not mediated by the observed changes in relative abundance of bacterial species[34] In a randomized cross over study it was found evident that the Flaxseed intake decreases glucose and improve insulin sensitivity as part of a habitual diet in overweight or obese individuals with pre-diabetes *Hutchins et al* (2013).[35]Dietary fiber intake is associated with lower body weight in epidemiologic studies. Flaxseeds provide satiety which in turn plays an important role in overeating. Overeating is one of causes giving rise to obesity and diabetes[36]**.** It is also a source of magnesium, a mineral which is key to blood-sugar control because it helps cells to use insulin.

CONCLUSION

Ayurvedic texts have mentioned hundreds of *Pathya Anna* according to the need and conditions of patients and diseases. Here we reviewed the food grains ascribed for benefits in Prameha (Diabetes) by Acharya Charaka. The current scientific evaluations and experimentations also justify the aforesaid benefits. The food that claims to improve health or well being by providing benefit beyond that of traditional nutrient it contains is assumed as to be functional food nowadays. It is need of hour to view the Ayurvedic *Pathya Anna* from this point of view in order to explore new dimensions to the concept of Functional food.it will be a right path to follow the verse “Let food be thy medicine and medicine be thy food” quoted by Hippocrates.

CONFLICT OF INTEREST: We declare that we have no conflict of interest.

ACKNOWLEDGEMENT: The authors like to thank Ayurvedic forefathers, the Pubmed central, Google scholar as well as concerned researchers for providing ease of accessibility to the research articles used in this review.

REFERENCES

1. Agnivesha, Charaka Samhita, Revised by Charaka and Dridhbala, yadavji Trikam ji acharya edited, published by Chaukhambha surBharti prakashan, Varanasi, reprint Edition- 2008;174.
2. Agnivesha, Charaka Samhita, Revised by Charaka and Dridhbala, yadavji Trikam ji acharya edited, published by Chaukhambha surBharti prakashan, Varanasi, reprint Edition- 2008;133.
3. Clare M. Hasler;Functional Foods: Their role in disease prevention and health promotion; A Publication of the institute of food technologists expert panel on food safety and nutrition, Nov 1998.
4. Agnivesha, Charaka Samhita, Revised by Charaka and Dridhbala, yadavji Trikam ji acharya edited, published by Chaukhambha surBharti prakashan, Varanasi, reprint Edition- 2008, p.p.448
5. Agnivesha, Charaka Samhita, Revised by Charaka and Dridhbala, yadavji Trikam ji acharya edited, published by Chaukhambha surBharti prakashan, Varanasi, reprint Edition- 2008;117.
6. Bhavamishra, Bhavprakash Nighantu; hindi commentary by KC Chunekar & GS Pandey, published by Chaukhambha Bharti Academy, Varanasi, reprint Edition- 2002; 656.
7. Yallanki Sireesha, Ramesh Babu Kasetti, Shaik Abdul Nabi, Sirasanagandla SwapnaChippada Apparao;Antihyperglycemic and hypolipidemic activities of *Setaria italica* seeds in STZ diabetic rats ;Pathophysiology, 2011;18(2);159–164
8. Lee SH, Chung IM, Cha YS, Park Y;Millet consumption decreased serum concentration of triglyceride and C-reactive protein but not oxidative status in hyperlipidemic rats; Nutr Res. 2010;30(4):290-6.
9. Bhavamishra, Bhavprakash Nighantu; hindi commentary by KC Chunekar & GS Pandey, published by Chaukhambha Bharti Academy, Varanasi, reprint Edition- 2002;.657.
10. Geervani P, Eggum BO;Nutrient composition and protein quality of minor millets; Plant Foods Hum Nutr. 1989; 39(2):201-8.
11. [11]Pattabiraman TN;Trypsin/chymotrypsin inhibitors from milletsAdv Exp Med Biol. 1986;199:439-48.
12. Vinoth A, Ravindhran R;Biofortification in Millets: A Sustainable Approach for Nutritional Security; Front Plant Sci. 2017;8:29.
13. Bhavamishra, Bhavprakash Nighantu; hindi commentary by KC Chunekar & GS Pandey, published by Chaukhambha Bharti Academy, Varanasi, reprint Edition- 2002;640.

14. McIntosh GH[1], Whyte J, McArthur R, Nestel PJ;Barley and wheat foods: influence on plasma cholesterol concentrations in hypercholesterolemic men;Am J Clin Nutr. 1991; 53(5):1205-9.

15. Ramakrishna R, Sarkar D, Manduri A, Iyer SG, Shetty K; Improving phenolic bioactive-linked anti-hyperglycemic functions of dark germinated barley sprouts (Hordeum vulgare L.) using seed elicitation strategy. J Food Sci Technol. 2017; 54(11):3666-3678.

16. Thondre PS, Wang K, Rosenthal AJ, Henry CJ;Glycaemic response to barley porridge varying in dietary fibre content; Br J Nutr. 2012; 107(5):719-24.

17. Choi JS, Kim H, Jung MH, Hong S, Song J;Consumption of barley beta-glucan ameliorates fatty liver and insulin resistance in mice fed a high-fat diet. Mol Nutr Food Res. 2010; 54(7):1004-13.

18. Sharma PV; Dravyaguna Vigyana Vol III; published by Chaukhambha Bharti Academy, Varanasi, reprint Edition- 2005,165.

19. Sharma PV ; Dravyaguna vigyana vol III;Chaukhambha bharati Academy, Reprint 2005;164-165

20. Joseph M. A Wika et al: Screening Methods to Measure Antioxidant Activity of Sorghum (Sorghum bicolor) and Sorghum Products; J. Agric. Food Chem. 2003; 51, 6657−6662

21. James L. Hargrove, Phillip Greenspan, Diane K. Hartle,, Christopher Dowd: Inhibition of Aromatase and α-Amylase by Flavonoids and Proanthocyanidins from Sorghum bicolor Bran Extracts; Journal of Medicinal Food;14;7-8.

22. Llopart EE, Cian RE, López-Oliva MME, Zuleta Á, Weisstaub A, Drago SR\;Colonic and systemic effects of extruded whole-grain sorghum consumption in growing Wistar rats. Br J Nutr. 2017; 118(8):589-597.

23. Kim E, Kim S, Park Y;Sorghum extract exerts cholesterol-lowering effects through the regulation of hepatic cholesterol metabolism in hypercholesterolemic mice; Int J Food Sci Nutr. 2015; 66(3):308-13.

24. Nguyen PH, Dung VV, Zhao BT, Kim YH, Min BS, Woo MH.;Antithrombotic and antidiabetic flavonoid glycosides from the grains of Sorghum bicolor (L.) Moench var. hwanggeumchal;Arch Pharm Res. 2014 Nov;37(11):1394-402. doi: 10.1007/s12272-014-0422-5. Epub 2014 Jun 24.

25. Aguerre M[1], Carriquiry M, Astessiano AL, Cajarville C, Repetto JL;Effect of sorghum grain supplementation on glucose metabolism in cattle and sheep fed temperate pastureJ Anim Physiol Anim Nutr (Berl). 2015 Jun; 99(3):465-73.

26. Bhavamishra, Bhavprakash Nighantu; hindi commentary by KC Chunekar & GS Pandey, published by Chaukhambha Bharti Academy, Varanasi, reprint Edition- 2002;658.

27. Prashant S.HegdeT.S.Chandra;ESR spectroscopic study reveals higher free radical quenching potential in kodo millet (Paspalum scrobiculatum) compared to other millets; Food Chemistry; V 92(1);2005;177-182
28. Jain S[1], Bhatia G, Barik R, Kumar P, Jain A, Dixit VK;Antidiabetic activity of Paspalum scrobiculatum Linn. in alloxan induced diabetic rats;J Ethnopharmacol. 2010 Feb 3; 127(2):325-8. doi: 10.1016/j.jep.2009.10.038. Epub 2009 Nov 10.
29. Bhavamishra, Bhavprakash Nighantu; hindi commentary by KC Chunekar & GS Pandey, published by Chaukhambha Bharti Academy, Varanasi, reprint Edition- 2002;650.
30. Parthsarthi, Purwar B, Saxena Y;Effect of Dolichos biflorus on blood sugar and lipids in diabetic rats; Indian J Physiol Pharmacol. 2013; 57(1):63-71.
31. Bhavamishra, Bhavprakash Nighantu; hindi commentary by KC Chunekar & GS Pandey, published by Chaukhambha Bharti Academy, Varanasi, reprint Edition- 2002; 652.
32. Adolphe JL, Whiting SJ, Juurlink BH, Thorpe LU, Alcorn J;Health effects with consumption of the flax lignan secoisolariciresinol diglucoside. Br J Nutr. 2010; 103(7):929-38.
33. Pan A, Sun J, Chen Y, Ye X, Li H, Yu Z, Wang Y, Gu W, Zhang X, Chen X, Demark-Wahnefried W, Liu Y, Lin X;Effects of a flaxseed-derived lignan supplement in type 2 diabetic patients: a randomized, double-blind, cross-over trial; PLoS One. 2007; 2(11):e1148.
34. Brahe LK, Le Chatelier E, Prifti E, Pons N, Kennedy S, Blædel T, Håkansson J, Dalsgaard TK, Hansen T, Pedersen O, Astrup A, Ehrlich SD, Larsen LH;Dietary modulation of the gut microbiota--a randomised controlled trial in obese postmenopausal women; Br J Nutr. 2015; 114(3):406-17.
35. Hutchins AM, Brown BD, Cunnane SC, Domitrovich SG, Adams ER, Bobowiec CE;Daily flaxseed consumption improves glycemic control in obese men and women with pre-diabetes: a randomized study; Nutr Res. 2013;33(5):367-75.
36. Clark MJ, Slavin JL;The effect of fiber on satiety and food intake: a systematic review; J Am Coll Nutr. 2013; 32(3):200-11.