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Effect of Carbohydrates on Muscles and Joints

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Abstract

Carbohydrates are the most abundant biomolecule produced on the earth, photosynthetic plants and algae convert over 100 billion metric tonnes of CO_2 and H_2O into sugar, starch and cellulose like substances. These are polyhydroxy aldehyde or ketones and their derivates or substances that yield such compounds on hydrolysis. Most carbohydrates have the empirical formula (CH_2O) n, some do not conform to it while others contain in addition to C, H and O elements such as Nitrogen, Phosphorous or Sulphur. Three major size classes of carbohydrates are Monosaccharides, oligosaccharides and polysaccharides. The saccharide means sugar. Monosaccharides are simple sugars consisting of a single polyhydroxy aldehyde or ketone unit, oligosaccharides consist of short changes of few (2-8) mono saccharide units joined together by characteristic glyosidic linkage. The most abundant monosaccharide and disaccharide found in nature are glycose (fruit sugar) and sucrose (cane sugar) the later consists of two 6-carbonsugar, D-glucose and D-fructose joined covalently. All common mono and disaccharides have names ending with suffix "ose".

Keywords: Carbohydrates; Muscles; Joints.

Introduction

Most oligosaccharides do not occur as free entities hut are joined to monocular molecules, such as: lipids or proteins (glycoconjugates). The polysaccharides are the high molecular weight, long chain compounds containing 100 or thousands of monosaccharide units either in liner or branched chain fashion which consists of recurring units of Dglucose but differ in the type of glycosidic linkage.

Material and method

(A) Biologically important carbohydrates:

In addition to simple carbohydrates, such as: glucose, galactose, fructose, and mannose, and a range of oligosaccharides and polysaccharides such as starch and cellulose, living organisms contain a variety of derived carbohydrates in which a hydroxyl group in the parent compound is replaced with another substituent or a carbon atom is oxidised to a carboxylic acid e.g.: glycolipid and glycoprotein. In sugar amines (glucoamine, galactoamine and manoamine) the hydroxyl group at c-2 of the parent compound is replaced with an amino group. The amino group many be condensed with acetic acid as in N-Acetyl glucose amine which forms part of many structural polymers of bacterial cell walls. The substitution of hydrogen for the hydroxyl group at C-6 galactose or mannose produces fructose or rhamnose respectively, forming deoxy sugars found in the complex oligosaccharides of glycoprotein and glycolipid.

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Nutritional aspects of carbohydrates

Dietary source of carbohydrates:

The three major constituents of food are carbohydrate, protein and lipid with small amounts of vitamins, minerals, pigments, flavouring substances and enzymes. Water is also present in foods in varying quantities. These constituents give foods their structure, texture, colour, flavour and nutritive value.

Carbohydrates are widely distributed in nature

in the form of sugars starch, cellulose and other complex substance. They provide the major part of energy in human diet 85% of the energy for the people of developing countries and about 40-45% of the energy of the more affluent western world, through neither of these extremes is desirable nutritionally, Englyst and Kigman [3.6] distinguished two types of polysaccharides from plant food, the storage polysaccharide, starch and the cell wall or chemically related structural polysaccharides that do not contain alpha-glyosidic linkage called non starch polysaccharides (NSP) cereal, grains, pulses and other seeds, roots vegetables and stem vegetables such as: potato, sweet potato, cashew contains large amount starch constituting the world's most important starchy foods (principle and readily measurable, food components termed as dietary fibre) The amount of carbohydrates in animal tissues is comparatively small in relation to their fat and protein content and is not important in dietary terms.

The proportion of starch, sugar and NSP in the diet is highly variable for the people of different communities in the world.

Monosaccharide and Disaccharide

Fruits and vegetables contain variable amounts of glucose and fructose, the latter being the major constituent of honey. Natural foods do not contain abundant glucose and fructose, but they can be made as invert sugars from sucrose by hydrolysis and used in a no. of food preparations and pharmaceuticals. Fructose is sweeter than sucrose whereas; glucose is only half sweet as sucrose. Mannose is uncommon in food, but it is present in mannaor lichen which is drought curl up into light balls from which bread can be made.

Oligosaccharides and Sugar Alcohols

The important oligosaccharides found naturally occurring in pulses (beans and peas) are raffinose, stachyose, and verbascose, containing glucose, fructose and galactose. These oligosaccharides are not hydrolysed by human endogenous enzymes, and like NSP, they are fermented in the large intestine producing gases such as; carbondioxide, hydrogen and methane and volatile fatty acids such as acetic, propionic, and butyric acids.

Polysaccharides

Starch is the principle storage polysaccharide of staple foods such as: cereals, potatoes, cashew and plantains. It is present in granular form in characteristic shapes specific to each species. Amylose is a linear polysaccharide containing alpha (1-4) type of glucosidic linkage, amylopectin is a branched chain polysaccharide with 15-30 alpha (1-4) linked glucose units in each Brach, the branches being joined by alpha (1-6) type of glucosidic linkage. The relative amounts of amylose and amylopectin vary among different plant sources, from about 2% amylose corn-starch to around 80% in high amylose corn-starch. Most other starches contain 15-35% amylose.

B: Role of Carbohydrates as Dietary Fibres

Dietary fibre has not been defined in chemical terms, which has led to delay in developing accurate methods of its measurements and misinterpretations of the studies on dietary fibre in human nutrition. Hipsley [7] estimated dietary fibre as the material derived from the plant cell wall in foods. Trowell [8] defined dietary fibre as the skeletal remains of plant cells that are resistant and to digestion by man's enzymes. However, Cummings and Englyst10 in 1978 proposed that dietary fibre should be measured as the non-starch polysaccharide in plant foods. Englyst defined dietary fibre as non-starch-polysaccharide (NSP) for food labelling because this gave the best index of plant cell wall polysaccharide as was in keeping with the original concept of dietary fibre.

Table 1: Classification of starch for nutritional purposes:

Type of starch	Example of occurrence	Probable digestion in small intestine
Rapidly digestible starch (RDS)	freshly cooked starchy food	Rapid
Slowly digestible starch (SDS)	most raw cereals	slow but complete
Resistant starch (RS) Physically inaccessible	partly milled grains and seeds	Resistant
Resistant starch granules	Raw potato and banana	Resistant
Retrograded amylose	cooked potato after cooling Bread, cornflake etc.	Resistant

Table 2: In vitro digestibility of starch in some foods:

Food	RDS (%)	SDS (%)	RS(%)	RS(%)	RS(%)
White flour	49	48	_	3	1
Short bread	56	43	_	_	1
White bread	94	4	_	_	2
White spaghetti	52	43	3	_	3
Banana biscuits	39	23	_	38	1
Potato biscuits	47	27	_	25	1
Haricot beans	18	42	18	9	12
Pearl barley	41	41	9	_	2

Food Source of Dietary Fibre

Engylst reported total soluble and insoluble dietary fibre contents of 178 fruits and vegetables and 114 cereal products. The total and soluble NSP and the composition of total NSP of some fruits are shown in Table 3. By employing gas chromatographic techniques, dietary fibre can be separated into cellulose and non-cellulosic polysaccharide (NCP) with values for the individual constituents' sugars which have different physiological role in human nutrition wheat; bran has a higher content of total NSP with a majority of insoluble parts. Cereals generally have greater portion of NCP xylose than arabinose but contains only traces of uronic acid. This contrasts with fruits and vegetables where Arabinose especially soluble NCP Arabinose, predominates. Also, fruits and vegetables have generally higher content of uronic acid.

Major NSP Polysaccharide

Cellulose, hemicellulose, pectin, beta glucan and gums and mucilage are the main polysaccharides constituting NSP, cellulose, the major component of cell walls of plants is the high molecular weight polymer containing up to 10,000 glucose units linked by beta 1-4 glyosidic bonds. Strong inters and intra molecular hydrogen bonding between cellulose chains is responsible for the formation of micro-fibrils and fibres and development of highly stable crystalline structures. The low chemical reactivity of cellulose thus explains its characteristic physical properties.

Table 3:

	Total NSP		Soluble NSP
Food	fresh weight	dry weight	dry weight
Wheat bran	36.0	41.1	4.2
White bread	1.6	2.7	1.6
Rye bread	7.3	13.3	6.7
Oatmeal	6.6	7.4	4.1
Cornflakes	0.9	0.9	0.4
Potato	1.2	6.4	3.8
Beans, French	3.1	30.4	12.7
Carrots	2.4	19.5	11.4
Cabbage	2.9	24.4	11.8
Tomato	1.1	18.8	7.4
Apples	1.7	12.5	5.4
Oranges	2.1	15.0	9.8

Table 4: Composition of non-starch polysaccharide of some foods (g/100g dry weight)

	Non-cellulosic polysaccharides							
Food	cellulose	RhaFuc	Ara	XylMan	Gal	GlcUAC		
Wheat bran	8.2	_	_	9.9	17.7	0.3	0.8	3.0	1.2
White bread	0.2	_	_	0.8	1.2	0.1	0.3	2.3	_
Rye bread	0.4	_	_	3.5	5.8	0.1	0.3	2.3	0.1
Oatmeal	0.4	_	_	0.9	1.3	0.1	0.2	4.2	0.3
Cornflakes	0.3	_	_	0.1	0.3	_	_	0.1	0.1
Potato	2.0	0.1	_	0.4	0.1	_	2.2	0.6	1.0
Beans, French	11.1	0.3	_	2.3	1.7	1.4	4.1	0.6	8.9
Carrots	6.4	0.7	_	2.0	0.3	0.4	3.4	0.1	6.2
Cabbage	8.0	0.7	_	4.6	1.0	0.5	2.7	0.1	6.8
Tomato	7.5	0.3	_	0.9	1.0	1.3	1.7	04	5.7
Apples	4.2	0.3	0.2	1.7	0.8	0.3	1.0	0.3	3.7
Oranges	3.4	0.3	_	2.2	0.6	0.4	1.8	0.1	6.2

Synthetic Carbohydrates

Polydextrose is a synthetic carbohydrate consisting of randomly cross-linked glucose polymers of different types. It is manufactured by thermal polymerization of glucose in the presence of citric acid and sorbitol. Polydextrose is available in two forms: an off-white amorphous powder and a light-yellow aqueous solution, both are non-sweet and tasteless, having functional properties like sucrose. Polydextrose is not digested in the small intestine and enters the colon where approximately 30% is fermented by the intestinal bacteria to volatile fatty acids and CO_2, the reminder is excreted in the faces [4.5].

Intake of dietary fibre

According to Bingham et al. [8] the average daily take-off dietary fibre in the United Kingdom is around 12g, both for men and for women, though there is considerable individual variation in the consumption of NSP, the omnivorous diet of some people may contain as much as 30g of dietary/ day. Fruits, vegetables and cereals constitute approximately 10%, 48% and 38% respectively, of source of dietary fibre in the diet of British people [9].

Nutritive and non-nutritive sweeteners

Sugars are a fairly good source of calories. Apart from their nutritive value, sugars have several other functions such as: humectants (absorption of moisture from air), plasticizers, texturizing agents, flavouring agents, and sweeteners. The flavour – producing function of sugars depends on the reactions sugars undergrow when they are subjected to heat during sterilization, cooking and dehydration. The sweetness of sugars depends on their ability to form hydrogen bonds with water, other polar compounds, and among themselves.

Effect of carbhohydrates on muscles and joints

Americans eats a lot of sugar, the data has given by department of agriculture of USA, the average American citizen take round about 47 pounds of cane sugar and 35 pounds of high fructose corn syrup per year [2]. We all know sugar is the main ingredient in the obvious villains such as candy, ice creams and other junk foods but there are also hidden sugars in most cooked foods. This includes many so called "healthy" foods such as such as whole grain breakfast cereals, granola bars, pasta sauce, yogurt and sports drinks. It is widely known that overconsumption of sugar causes obesity, diabetes, and heart disease, but did you know that it could be contributing to your muscle and joint pain as well.

There is nothing good about inflammation

Research [1,4] has shown that taking of foods which is high in sugar may cause inflammation. Many studies measuring inflammation by doing blood tests called C-reactive protein (CRP) discovered the foods with a high concentration of sugar level in CRP. This occurs because foods having sugar can cause a spike in a hormone known as insulin that starts a cascade of biochemical reactions that leads to the production of inflammation. Pancreas secrets insulin is responsible for taking sugar out of the blood vessels and storing it in the cells which also contributes to the fat deposition. Visceral fat or stomach fat itself secrets inflammatory proteins and hormones which can cause chronic inflammation. Most forms of joint pain and muscle aches involve inflammation even if pain is the result of the trauma.

Sugar can cause pain in the joints

Sugar also can cause joint pain and stiffness experienced with aging through a process called glycation. Glycation occurs when sugar bonds with proteins to form compounds called advanced glycation end products (AGEs). These compounds damage the body cells by speeding up the oxidative processes and changing normal cell behavior. AGEs are thought to be a major factor in aging as well as contributing to many ages related chronic disease. Research [4] has shown that deposition of AGEs in joint tissues can cause change in articular cartilage making the cartilage more susceptible to damage and development of osteoarthritis.

Discussion

Carbohydrates play an important role in providing energy to our cells and depletes some minerals which are good for muscle contraction and relaxation. Glucose is the most important energy source of carbohydrate to the mammals. The bulk of dietary carbohydrate is digested and finally absorbed as glucose into the body. But excess of sugar intake also contributes to joint pain and stiffness. According to the Dr. Natasha Campbell McBride, author of the book "Gut and psychology syndrome", the body requires at least 28 molecules of magnesium to metabolize a single molecule of

sugar. Therefore, a diet high in sugar can deplete the body of this very important mineral that is essential for maintaining proper muscle contraction and relaxation [9]. If you suffer with joint or muscle ache and pain, try to eliminate sugar from your diet and focus on eating the real food provided by nature.

Conclusion

Carbohydrates are good source of energy for human cells and plants. It also gives structural component to the plan cells. It also provides immediate energy in the form of glucose and gets stored energy in the form of glycogen but at the same time it also causes the pain in the joints and can cause osteoarthritis which makes the articular cartilage more susceptible to damage. But sugar depletes some important minerals that are needed for proper muscle contraction and relaxation. A high sugar in diet may cause loss of minerals such as magnesium, potassium and calcium in the urine.

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