

A COMPARATIVE STUDY OF REDUCING SUGAR CONTENT IN SELECTED BREAKFAST CEREALS PROCESSING METHODS

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Abstract

Diabetes mellitus – a complex metabolic disorder – is a common disease affecting 2-4% of the Indian population, and a majority of them (90%) are diagnosed as non-insulin dependent diabetes mellitus (NIDDM). In the management of NIDDM, diet has been recognised as a cornerstone of therapy. Diabetes is a long-term condition that causes high blood sugar levels. In order to keep blood sugar levels healthy, it is important to eat foods that digest slowly to avoid any spikes in blood sugar. Those foods that have the least effect on raising blood glucose are called low Glycemic Index foods, or low GI for short. Many natural foods have a low GI, such as cereals, legumes, milk and peanuts. No matter what type of diabetes you have, keeping your blood glucose levels within a healthy range is crucial. And starting the day with a healthy breakfast is one step you can take to achieve that. Breakfast should be a balanced meal with adequate protein, carbohydrates, and healthy fats. It should also be low in added sugar and high in fibre and nutrients. The investigators first identified commonly used breakfast cereals. A survey was conducted in 25 families of Pandalam, Pathanamthitta district, on the usage of breakfast foods. As per the survey results, according to the usage percent, top five cereals were selected for the current investigation. The main aim of the current study was to identify the reducing sugar content of the selected five cereals in three different processing methods. This will help the diabetic patients in selecting the breakfast cereals and the processing methods for their healthy diet.

Keywords: Diabetes, Glycemic Index, Breakfast, Cereals

Introduction

Diabetes is a long-term condition that causes high blood sugar levels. In type 1 diabetes, the body does not produce insulin. Approximately 10% of all diabetes cases are type 1. In type 2 diabetes, the body does not produce enough insulin for proper function. Approximately 90% of all cases of diabetes worldwide are of this type. Gestational diabetes type affects females during pregnancy.

The most common diabetes symptoms include frequent urination, intense thirst and hunger, weight gain, unusual weight loss, fatigue, cuts and bruises that do not heal, male sexual dysfunction, numbness and tingling in hands and feet. Research shows that both the amount and the type of carbohydrate in food affect blood glucose levels. There's really no doubt anymore that excess sugar can be toxic to human body,

and it's only a matter of time before it will be commonly accepted as a causative factor of most cancers, in the same way as we accept that smoking and alcohol abuse are direct causes of lung cancer and cirrhosis of the liver.

Breakfast is the most important meal of the day. Most of the people skip their breakfast for a variety of reasons. Cereals are a healthy meal full of vitamins, fibre and minerals. It is also low in fat and calorie. Cereals that are high in fibre and are made with whole grains are perfect for the breakfast. You can have cereals every morning to stay energetic whole day. The best cereal is the whole grain cereal that can be either made with oat, shredded wheat, bran or brown rice.

In all, there are at least 25 types of Indian breakfasts, each consisting of a choice of over

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100 different food items (Jaffrey, 2015). Each state in India has different specialties and items for breakfast. Thus there is no single standard Indian breakfast, with items changing with regions. However, one can broadly classify breakfast varieties in India into two types; North Indian and South Indian. The eastern and western parts of India also have individual breakfast items unique to their culture or state.

A typical south Indian breakfast consists of idli, vada or dosa coupled with chutney and sambar. Many variations of these dishes exist such as Rava idli, thayir vadai (yogurt vada), sambar vada and masala dosa. Other popular south Indian breakfast items are pongal, bisibelebath (sambar rice), upma, and poori. The state of Kerala has some special breakfast items such as appam, parotta, puttu, idiyappam and palappam.

A typical north Indian breakfast may either be a type of paratha or roti served with a vegetable curry, curd and pickles. There are several varieties of parathas available depending on the type of stuffing such as aloo (potato) paratha, Paneer (cottage cheese) Paratha, Mooli Paratha (Radish Paratha), etc. Other popular breakfast items in the north are poori bhaji, poha and bhindi bhujia.

Among Bengals roti and curry are the general variants in breakfast. The menu may also include "Indian French toast" which is also known as "Bombay toast", chire bhaja (flaked rice fried in oil and salt is added to it according to taste) and boiled eggs.

In Western India, a Gujarati household may serve dhoklas, khakhra or theplas for breakfast, the most popular of which is methi thepla. In Mangalore the breakfast delicacy Oondees may be served.

The glycemic index (GI) is a ranking system devised to measure how quickly carbohydrates are released into the body. Carbohydrates affect

blood sugar and insulin levels. Slow-releasing carbohydrates are low on the glycemic index and can keep your blood sugar levels stable. Foods higher up the glycemic index will release their energy quicker, often causing the blood sugar levels to rise and fall rapidly. Following a low glycemic index diet helps control diabetes, and also plays a role in cardiovascular disease prevention.

Glycemic Index (GI) of 55 or less are considered 'low', those of 56–69 are 'medium' and those of 70 and above are 'high'. A study of 235 types of rice from around the world, by IRRI and CSIRO's Food Futures Flagship, found that the GI varies by type of rice, from a low of 48 to a high of 92 (average 64), with most scoring a low to medium GI. This means that rice and rice products can be part of a healthy diet for the average consumer and part of a low GI diet to help those with Type II diabetes better manage their condition.

Cereal grains are grown in greater quantities and provide more food energy worldwide than any other type of crop (Giovannini *et al.*, 2008) and are therefore staple crops.

In their natural form (as in whole grain), cereals are a rich source of vitamins, minerals, carbohydrates, fats, oils, and protein. When refined by the removal of the bran and germ, the remaining endosperm is mostly carbohydrate. In some developing nations, grain in the form of rice, wheat, millet, or maize constitutes a majority of daily sustenance. In developed nations, cereal consumption is moderate and varied but still substantial.

Consumption of whole grains has been linked with a decrease in cardiovascular disease, cancer, and death (Giovannini *et al.*, 2008). Regular whole-grain consumption lowers LDL and triglyceride levels, which contributes to an overall 26% reduction in coronary heart disease-risk factors. In addition, whole-grain consumption is inversely related to hypertension, diabetes, and obesity when compared to refined

grains, all of which are negative indicators in total cardiovascular health (Maki *et al.*, 2016).

Cereals are the most important source of plant food to the man. They are considered a gift of Ceres – Roman Goddess of Agriculture. All cereals belong to the grass family and their characteristic fruit is caryopsis in which pericarp remains completely fused with seed coat. They are rich in carbohydrates, proteins, oils and vitamins.

The aim of the study was to first identify commonly used breakfast cereals and their cooking methods. Conduct a survey in 25 families of Pandalam, Pathanamthitta district, on the usage of breakfast foods. As per the survey results, according to the usage percent, select the top five cereals for the current investigation. They are *Oryza sativa*, *Triticum aestivum*, *Zea mays*, *Eleusine coracana* and *Avena sativa*. The three different processing methods adopted are steaming, boiling and roasted and powdered forms. The main aim of the current study is to identify the reducing sugar content of the selected five cereals in the three different processing methods. This will help the people in selecting breakfast cereal for their healthy diet, especially diabetic patients. It is important for the diabetic patients to maintain their sugar level.

Materials and Methods

Materials

Five different varieties of commonly used breakfast cereals in Kerala were considered for the present investigation. Materials were selected based on the survey conducted in hundred persons from different families at Pandalam, Pathanamthitta district. Based on the survey results, top five varieties of the cereals namely *Oryza sativa*, *Triticum aestivum*, *Zea mays*, *Eleusine coracana* and *Avena sativa* were selected for the study. The cereals were collected from provision stores in Pandalam.

Methods

1. Morphological parameters

Morphological parameters of the selected varie-

ties of the cereals considered were shape, colour, fresh weight, dry weight, percentage of moisture content.

2. Processing of Samples

Three different processing methods adopted for the present investigation are steaming, boiling and powder after roasting. All the five selected breakfast cereals were treated uniformly in the controlled condition – normal cooking conditions.

3. Biochemical studies

Biochemical parameter, reducing sugar content, of five different varieties of cereals using the three processing methods was studied.

Estimation of reducing sugar content: Reducing sugar content was estimated by using Di-Nitro Salicylic acid (DNS) method. DNS reagent is used in the assay. Weighed flour of each cereal (1 gm.) was homogenized in distilled water with a motor and pestle. The batter was carefully filtered through cheese cloth and made up to 10 ml. using distilled water. The filtrate was centrifuged at 5000 rpm. for ten minutes. From each sample, 0.5 ml was pipett into test tube and 1.5 ml. of distilled water added to make up to 2 ml. Then to this 2 ml. of DNS was added. Another test tube was taken and prepared a blank solution containing 2 ml. distilled water and 2 ml. DNS reagent. It is then heated in a boiling water bath for five minutes. The reaction was noticed by the colour change from yellow to orange-red in test tube containing sample and no colour change in the test tube containing blank. The samples along with the blank were cooled and added distilled water to make up to 10 ml and read optical density (OD) at 510 nanometre. The total reducing sugar content was estimated by using the formula

Total reducing sugar =

Con. of std. x OD of sample x Total volume of extract

OD of std. x Vol. of sample x Weight of sample

Results and Discussion

Selection of Cereals

Breakfast is the first meal of a day, most often eaten in the early morning before undertaking the day's work (Giovannini *et al.*, 2008). The word literally refers to breaking the fasting period of the prior night. There is a strong tendency for one or more "typical", or "traditional", breakfast menus to exist in most places, but the composition of this varies widely from place to place, and has varied over time, so that globally a very wide range of preparations and ingredients are now associated with breakfast.

Five different varieties of breakfast cereals were taken for consideration and the survey results are presented in Table 1. In the present investigation on five different varieties of cereals, the morphological and biochemical – reducing sugar in three different processing methods of the samples were studied.

Morphology of the Fruit

The five different varieties of cereals had shown difference in the morphology. The characters studied and the differences observed are represented in Table 2. Shape and colour of seed coat, which are the external appearance, had shown variation among the five varieties.

A cereal is any grass cultivated for the edible components of its grain (botanically, a type of fruit called a caryopsis), composed of the endosperm, germ, and bran. Cereal grains are grown in greater quantities and provide more food energy worldwide than any other type of crop (Giovannini *et al.*, 2008) and are therefore staple crops.

Biochemical studies

Consumption of whole grains has been linked with a decrease in cardiovascular disease, cancer, and death (Giovannini *et al.*, 2008). Regular whole-grain consumption lowers LDL and triglyceride levels, which contributes to an overall 26% reduction in coronary heart disease -risk factors. In addition, whole-grain consump-

tion is inversely related to hypertension, diabetes, and obesity when compared to refined grains, all of which are negative indicators in total cardiovascular health (Maki *et al.*, 2016).

Study of only the reducing sugar content was conducted in the five widely used cereals in three different processing methods. The results (Table 3) revealed that the highest content of reducing sugar per gram of the samples was found in steamed processing and the lowest observed in roasted and powdered samples. Different cereals had shown great variation in reducing sugar content between the processing methods and themselves.

Among the five different breakfast cereals, the highest reducing sugar value (1.104) was observed in *Zea mays* and the lowest (0.512) was seen in *Oryza sativa* in steaming process. The other cereals had shown the values in an order *Eleusine coracana* (1.096), a value near to the highest one, *Avena sativa* (0.800) and *Triticum aestivum* (0.568).

According to Carroll (2016), keeping grains as close to their original form as possible slows or prevents the digestion of starch, and a slower digestion is responsible for preventing spikes in blood sugar (over time spikes in blood sugar may lead to insulin resistance).

After boiling process, the five different cereals had shown great variation in their reducing sugar content. The highest value was noticed in *Avena sativa* (0.968) and the lowest value 0.308 was observed in *Oryza sativa*. The reducing sugar value in *Triticum aestivum* was 0.552 and in *Eleusine coracana* it was 0.852.

During the past few decades, dietary modification in the treatment of diabetes mellitus has advanced from alterations in nutrient constituents (mainly carbohydrate, CHO) of a meal to alterations in the whole meal itself. Recent studies (Crapo *et al.*, 1977 and Jenkins *et al.*, 1981) have suggested that not only should the carbohydrates ingested be considered when

planning a diet for those with diabetes, but also the biological equivalents (that is, quantities of food yielding the same effect on blood glucose) or the glycaemic response (index) of a food. For an effective dietary management of diabetes, it is better to modify the diet appropriate to the individual lifestyle, taking into consideration traditional eating patterns for better and longer compliance.

The reducing sugar content was very low in all the five different breakfast cereals in roasted and powdered form. The highest value 0.528 was met with *Zea mays* and the lowest value 0.096 in *Oryza sativa*. Almost a near value observed in *Triticum aestivum* (0.104) and *Avena sativa* (0.144).

The glycaemic responses of common Indian breakfast items have been studied (Raghuram *et al.*, 1987, Vishwanathan *et al.*, 1988 and Vimala and Easwaran, 1988), but there is a paucity 1000 of data on the glycaemic responses of the typical cereal (rice) based preparations of Kerala. Hence, this study assessed the glycaemic response of some breakfast items commonly consumed by Keralites in non-insulin dependent diabetic subjects.

A comparison among the five different breakfast cereals and in the three different processing methods (Graph 1), the steamed *Zea mays* had shown highest reducing sugar value 1.104. The amount of reducing sugar was very less in roasted and powdered *Oryza sativa* (0.096).

All cereals are members of the grass family, Gramineae, and are similar in possessing the characteristic fruit of that family, the caryopsis. In this fruit the wall of the seed is fused with the ripening ovary wall to form the husk. The term “grain” is given either to this type of fruit or to the plant that produces it. There are six true cereals in the world today, which are Wheat, Rye, Rice, Oats and maize. Of these wheat, maize and rice are the most important, and each has played roles in the development of civilizations.

The reducing sugar content was very low in all the five different breakfast cereals in roasted and powdered form. The highest value was met with *Zea mays* and the lowest value in *Oryza sativa*. Almost a near value observed in *Triticum aestivum* and *Avena sativa*. A comparison among the five different breakfast cereals and in the three different processing methods, the steamed *Zea mays* had shown highest reducing sugar value. The amount of reducing sugar was very less in roasted and powdered *Oryza sativa*.

Table 1. Widely used cereal varieties

Cereals	Usage Percent	Position
<i>Oryza sativa</i>	100%	1
<i>Triticum aestivum</i>	93%	2
<i>Avena sativa</i>	78%	3
<i>Zea mays</i>	69%	4
<i>Eleusine coracana</i>	52%	5

Table 2. Morphology of selected cereal varieties

Sl. No.	Cereals	Shape	Colour
1	<i>Oryza sativa</i>	Elliptical and elongated	White or brown
2	<i>Triticum aestivum</i>	Elliptical and elongated	Golden yellow
3	<i>Avena sativa</i>	Elliptical and elongated	Dark golden yellow
4	<i>Zea mays</i>	Round to triangular	Ivory to golden yellow
5	<i>Eleusine coracana</i>	Small and round	Reddish to brown

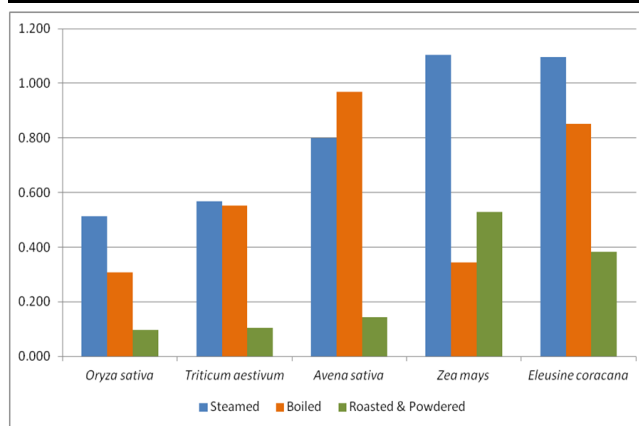


Figure 1. Comparison of Reducing Sugar Content in Samples vs. Processing Methods

Table 3. Reducing sugar content ($\mu\text{g}/\text{gm}$) of selected cereals in different processing methods

Sl. No.	Cereals	Steamed	Boiled	Roasted & Powdered
1	<i>Oryza sativa</i>	0.512	0.308	0.096
2	<i>Triticum aestivum</i>	0.568	0.552	0.104
3	<i>Avena sativa</i>	0.800	0.968	0.144
4	<i>Zea mays</i>	1.104	0.344	0.528
5	<i>Eleusine coracana</i>	1.096	0.852	0.384

Conclusion

Studies were undertaken on the morphology and biochemical studies in five different commonly used breakfast cereals belonging to the family Poaceae. Morphologically, the three cereals *Oryza sativa*, *Triticum aestivum* and *Avena sativa* had shown similarity in their colour and shape of the seeds. The other two cereals are different in their seed colour and shape.

Estimation of reducing sugar content in five breakfast cereals after three different processing revealed that the highest content of reducing sugar per gram of sample was found in steamed *Zea mays* and lowest value observed in roasted and powdered sample of *Oryza sativa*. When the three different processing methods were compared, lowest reducing sugar content was seen in the roasted and powdered cereals whereas the highest was observed in steamed cereals.

Glycemic Index (GI) is a measure of the relative ability of carbohydrates in foods to raise blood sugar levels after eating. High GI food is easily digested and absorbed by the body, which can result in fluctuations in blood sugar levels. Foods with low GI, on the other hand, are those with slow rates of digestion and absorption, causing a gradual and sustained release of sugar into the blood, which is beneficial to health and reduces the chances of developing Type II diabetes.

Slow digesting starches lower the body's insulin response, thus helping people with diabetes to normalize their blood sugar. Currently, 285 million people, mostly in developing countries, have Type II diabetes and another 344 million

are at risk of developing it due to impaired glucose tolerance. If diabetes is undiagnosed, it leads to chronic conditions and death. Consumption of cereals is not necessarily a cause of Type II diabetes, but cereals containing particular structures of starch offer a solution for prevention and management of the condition.

It is important to know what things affect the GI. Processing, cooking methods and the type of grain can all impact how quickly the food is digested. Cereals that are more processed tend to have a higher GI even if they have fibre added to them. Mixing foods can also affect the GI. Having protein and health fats with your cereal can help prevent spikes in blood sugar. The investigators concluded that the roasted and powdered form of *Oryza sativa* (rice) steamed or boiled and *Triticum aestivum* (wheat) steamed are good breakfast food for diabetic patients.

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