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Estimation and comparative analysis of caries promoting trace elements present in organic and non-organic staple cereal food grains consumed in Central Gujarat: an In vitro study.

Dr. Priya Shetty, Dr. Ramya R Iyer
MDS student, Department of Public health Dentistry, K.M.Shah Dental college and Hospital, Sumandeep Vidyapeeth, Vadodara, Gujarat.
Professor, Department of Public health Dentistry, K.M.Shah Dental college and Hospital, Sumandeep Vidyapeeth, Vadodara, Gujarat.

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ABSTRACT: The staple cereal food grains majorly consumed in Gujarat are wheat, rice and bajra. Trace elements are chemical element required by living organisms in minute amounts. The aim of the study was to estimate and gain understanding of the concentration of trace elements- magnesium, cadmium and selenium present in organic and non-organic staple food-grains (rice, wheat and bajra) consumed in Central Gujarat using chemical and atomic absorption spectrophotometric methods. The highest amount of magnesium was seen in non-organic bajra. The amount of cadmium was only detected from non-organic wheat which was 0.26 mg/kg. Selenium was not detected in any of the organic and non-organic food grains analysed. Magnesium was the only caries-promoting trace element detected from all the cereal food grains analysed .

KEYWORDS: caries promoting trace elements, food grains, organic , non-organic.

I. INTRODUCTION

Nutrition is defined as the science which deals with the study of nutrient and foods and their effects on the nature & function of organism under different condition of age, health & disease. Diet is defined as total oral intake of a substance that provides nourishment & energy.[1]

Advances in agriculture have improved the production and yield of food crops. However, there is a concern that technological processes and chemicals may be the reason for unhealthy foods, which may be rich in energy but may not have essential minerals. They usually include cereals, legumes, nuts and seeds that are carbohydrates, protein- and lipid-rich, respectively, and also contain high density in bioactive protective phytochemicals and micronutrients, and which contain low glycemic index.[2]

Staple foods are consumed daily on a regular basis and provide a large percentage of the energy and nutritional needs of a person. [3]

The most commonly consumed staple cereal grains in Gujarat are wheat, rice and bajra.[4] Cereal food grains are source of carbohydrate and contain several macro elements and trace elements required for functioning of body as they are rich in nutritional value.

Trace elements (or trace metals) are minerals which are present in living tissues in very minute amounts. Trace elements act by functioning predominantly as catalysts in enzyme systems. All trace elements are considered as poisonous when eaten for long periods at adequately elevated concentrations.[5]

Trace elements are chemical elementrequired by living organisms in minute amounts (that is less than 0.1 percent by volume (1,000 parts per million).[6] According to WHO classification, there are 19 trace elements which are classified into three groups: essential elements, probably essential elements and potentially toxic elements. Deficiency of one trace element is not associated with any specific clinical presentation, but rather presents as a combination as each trace element are associated with many enzymes.[7]

Based on human and animal studies, Navia has summarized the cariogenic effect of the minerals and have enlisted them which indicate their relative cariogenicity.[8] Navia classified minerals based on their cariogenicity as cariostatic elements, mildly cariostatic, doubtful, Caries inert and Caries promoting. Navia had indicated that caries promoting minerals were Se, Mg, Cd. Also there are many studies that have shown that there is increase in dental caries with the intake of selenium, magnesium and cadmium. [9-11] As Selenium, Magnesium and Cadmium were found to be caries

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prompting trace elements, analysis of these trace elements in the cereal grains is of importance.

In recent times the use of organic food items is promoted and widely accepted as a holistic sustainable production system that favours environmental preservation, agro-biodiversity and biological cycles, increases soil fertility, minimizes pollution, and also leads to reduced use of chemical fertilizers and pesticides. They also have greater nutritional benefits, lower content of environmental contaminants, and lower risks to human health.[12] Also, use of synthetic materials is not allowed in organic food item production. Studies have proven that trace elements concentration of wheat is increased by use of fertilizers which suggest that use of fertilizers influence the uptake of trace elements in the food grains.[13] This suggests that there are chances that the elements from the fertilizer are incorporated in the non- organic food-grains.

Therefore, a need was felt to undertake a study to estimate and compare caries promoting trace elements present in staple cereals food grains in organic and non-organic staple foods consumed in Central Gujarat. Therefore, it was hypothesised that there may be increased amount of caries promoting trace elements in the non-organic staple cereal food grains as compared to organic staple cereal food grains, which are consumed in Central Gujarat. The aim of the study was to estimate and compare amounts of caries promoting trace elements present in staple cereal food grains (rice, wheat and bajra) in organic and non-organic staple foods consumed in Central Gujarat. The objectives of the study were to estimate the amounts of caries promoting trace elements in organic and non-organic staple cereal food grains (rice, wheat and bajra) consumed in Central Gujarat using chemical and atomic absorption spectrophotometric methods.

II. MATERIALS AND METHODOLOGY:

The present study was an in- vitro laboratory experimental research. The commencement of the study was undertaken after obtaining approval from the Sumandeep Vidyapeeth Institutional Ethical Committee (SVIEC). Approval had been obtained from Baroda Analytical Services, Gujarat Industrial Development Corporation (GIDC), Vadodara to conduct the study in their laboratory. The samples that were used in the study were organic and non-organic cereal food grains which included rice (white & Brown), wheat and bajra. The samples were procured from commercially available local retail outlets (Reliance retail limited, 24 mantra organic, Royal organic).

There were 4 samples for organic trace element analysis and 4 samples for inorganic trace element analysis and 30grams of each sample were sent to the laboratory.

The trace elements that were checked were Selenium, Magnesium and Cadmium which are caries promoting. These elements were tested by chemical and spectrophotometric methods as prescribed by the Pharmacopoeia Standards[14] for testing and as performed in the previous studies for trace element testing.[15-16]

The procedures involved were:

(a) The initial procedure carried out was Pre-treatment. The products were homogenized using equipment which were noncontaminating. It was checked if there were any leaching metals into the apparatus so that the apparatus was free from any metal parts.

(b) The procedure of drying was carried out . 10g test portion were weighed in a crucible. After that they were dried in either a drying oven, or a water-bath, or a hot plate and this procedure was carried out at 100°C.

(**c**) The procedure of ashing was carried out after drying.

(1) Ashing in a programmable furnace- A dish was placed on a furnace at initial temperature which was not higher than 100°C. The temperature was increased at a common rate of 50°C/hour and was increased to 450°C. The dish was allowed to stand for at least 8 hours or overnight.

(2) Ashing in a muffle furnace withthermostat following drying and pre-ashing in a apparatus- A crucible was taken which contained the test portion and it was covered with the glass cover. This crucible was placed on the ceramic plate, and it allowed purified air coming through a glass tube to sweep over the top of the product. Infrared lamp was put down at the cover. By slowly increasing temperature, pre-ash of sample was carried out with Infrared lamp. Pre-ashing was achieved by gradually increasing temperature on hot plate from minimum to maximum.

On the ceramic plate, the final temperature which was maintained was 300°C. Time required for pre-ashing was different for different product. The crucible was placed in muffle furnace at 200–250°C and slowly the temperature was raised to 450°C at a rate of no more than 50°C/h. The crucible was allowed to stand at this temperature for 8hrs or overnight. The crucible was removed out of furnace and it was allowed to cool. Wet ash was carried out with 1–3 mL water and then it was allowed to evaporate on a water- bath or hot plate. The crucible was put back in the furnace at no more than 200°C and the temperature was raised to 450°C. The process of ashing was carried out at 450°C for 1–2 hrs or longer. This procedure was

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continuously repeated until the product was completely ashed and it was white/grey or slightly coloured. Number of repetitions required varied depending on type of product. It was ensured that all ash came into contact, 6M HCl was added to crucible. After that acid was allowed to evaporate on water-bath or hot plate. The residue was dissolved in 10.0–30.0 mL, to the nearest 0.1 mL, of 0.1M HNO_3.

The crucible was swirled with utmost precaution so that all ash came into contact with acid. It was covered with watch glass and was allowed to stand for 1–2 hours. Then the solution was stirred in crucible properly with stirring rod. Then the contents were transferred to plastic bottle.

d) Atomic absorption spectrophotometry: The readings were noted for each sample of the food grains which include organic and non-organic white rice, brown rice, wheat and bajra. The amounts of the estimated trace elements were verified in triplicate and exact value was provided in mg/kg (ppm).

III. RESULTS:

Table 1: The concentration of Magnesium, Cadmium and Selenium in the Organic foodgrains-

Sr. No	Organic food grain	Magnesium (mg/kg) /ppm	Cadmium (mg/kg) /ppm	Selenium (mg/kg) /ppm
1.	Organic bajra	1400	Not detected	Not detected
2.	Organic White rice	700	Not detected	Not detected
3.	Organic brown rice	900	Not detected	Not detected
4.	Organic wheat	900	Not detected	Not detected

Table 2: The concentration of Magnesium, Cadmium and Selenium in the Non-Organic foodgrains-

Sr. No	Non-Organic food grain	Magnesium (mg/kg) /ppm	Cadmium (mg/kg) /ppm	Selenium (mg/kg) /ppm
1.	Non-Organic bajra	2300	Not detected	Not detected
2.	Non-Organic White rice	2000	Not detected	Not detected
3.	Non-Organic brown rice	900	Not detected	Not detected
4.	Non-Organic wheat	800	0.26	Not detected

The laboratory testing provided the concentration of the trace element testing. The results were compiled and assessed for reading and interpretation.

Table 1 shows the amount of magnesium, cadmium and selenium in the organic cereals. It was observed that the amount of magnesium in organic white rice, brown rice, wheat and bajra was 700 ppm, 900ppm, 900ppm, 1400ppm respectively. It was also noted that cadmium and selenium was not detected in organic brown rice, organic white rice, organic bajra and organic wheat.

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Table 2 shows the amount of magnesium, cadmium and selenium in the non-organic cereals. It was noted that the amount of magnesium in non-organic white rice, brown rice, wheat and bajra was 2000ppm, 900ppm, 800ppm and 2300ppm respectively.

It was observed that the amount of magnesium was same in both organic and non-organic brown rice (900 ppm). The amount of magnesium was high in non-organic white rice (2000 ppm) as compared to organic white rice (700 ppm). The amount of magnesium was higher in non-organic bajra (2300 ppm) as compared to organic bajra (1400 ppm). The amount of magnesium was higher in organic wheat (900 ppm) as compared to non-organic wheat (800 ppm).

It was noted that the highest amount of magnesium was seen in non-organic bajra (2300 ppm). The cadmium was only detected from non-organic wheat which was 0.26ppm. Selenium was not detected in any of the organic and non-organic food grains analyzed.

IV. DISCUSSION:

Enzymes of the trace elements are component of many biological and chemical reactions. They work in harmony with proteins and other co enzymes. Trace elements or micro-nutrients are chemical elements which are essential in minute amounts, usually as part of a vital element. Trace elements play a very important role in a variety of processes which are needed for life, the occurrence of deficiencies of any of trace elements is uncommon due to the strong homeostatic mechanisms.[17]

Trace elements play a role in influencing the susceptibility of the tooth to caries. Trace elements bring about alteration in the resistance of the tooth structure or modify the local environment at the tooth plaque interface. They bring about changes in the chemical and physical composition of the tooth especially at the enamel layer. They alter the size of the enamel crystal available for acid exposure thus playing a role in the pathology of caries. [18]

Studies indicate that combinations of elements, present in food or water protect the teeth. Based on human and animal studies, Navia has best summarized the cariogenic effect of many of the minerals in a list compiled to indicate relative cariogenicity. [8]

1. Cariostatic elements which were F, P
2. Mildly cariostatic elements which were Mo, V, Cu, Sr, B, Li, Au
3. Doubtful which were Be, Co, Mn, Sn, Zn, Br, I
4. Caries inert which were Ba, Al, Ni, Fe, Pd, Ti
5. Caries promoting elements which were Se, Mg, Cd, Pt, Pb, Si

Several studies have shown that there was increase in dental caries in cases where there had been increased selenium intake. [19] Various Studies have also brought into light that there is direct relationship between susceptibility of dental caries and presence of selenium excreted in urine in children who were living in areas where selenium did not occur naturally. [19,11] Also there are studies that showed existence of strong association between the development of dental caries and cadmium intake during the period of tooth development. [20]

As the amount of trace elements varies from one food grain to another, it is essential to know the cariogenicity of individual food grain. As various studies have indicated that caries promoting minerals were Selenium, Magnesium, Cadmium it is important to know the amount of theses trace elements in the cereal foodgrains which are consumed on daily basis.

In the present study it was observed that both the organic and non-organic brown rice showed equal amount of magnesium. However, the amount of magnesium was higher among non-organic white rice as compared to organic white rice. Also, the amount of magnesium in organic brown rice was higher as compared to organic white rice. This result were similar to the study by Srikumar[21] where lower content of magnesium was found in white rice as compared to brown rice. The findings could be due to loss of magnesium during the procedure of rice polishing.

The amount of magnesium in non-organic bajra was higher than organic bajra. Similar findings were found in the study conducted by Pires P C et al [12] where there was increase in amount of Mg, P, Na and K content in conventionally grown persimmon which included the use of chemical fertilizers for the cultivation. This indicates that the magnesium was incorporated into the cereal food grains from the chemical fertilizers that was used for the cultivation.

Selenium which is essential trace element is a vital component of antioxidant enzymes. Selenium are required in trace amounts for cellular functioning. However excessive amount is toxic.[7] However selenium was not detected in organic and non-organic white rice, brown rice, wheat and bajra that were analysed in the present study. This may have occurred due to reduced accuracy in the equipment in the detection of minute amounts of the trace elements in the food grains.

After the intake of cadmium, it is found to accumulate in the liver and bones and is excreted from the body at a very slow rate. Various studies

have suggested that there is strong relationship between formation of dental caries and the intake of cadmium during the dental development stage.[17] In the present study it was observed that cadmium was detected only in non-organic wheat. Cadmium was not detected in any of the organic and non-organic white rice, brown rice, bajra and wheat.

The variation which was found in the concentrations of trace elements in these food items may be explained by factors such as element content of soil, variation that would have occurred in element uptake among different plants, use of fertilizers and processing techniques. The actual intake levels of the elements from the food items may vary from the present estimates calculated after undergoing analysis of the cooked food items.

Interpretation of the present results should be carried out with caution as they are based on a limited number of food items from a single state of the country. The limitation of the study was that the cereal food grains analysed was concentrated to central region of the state of Gujarat. For the analysis of the amount of trace elements in the food grains, raw food grains were used as the equipment feasible could uptake only raw food grains.

V.CONCLUSION

From the results of the present study, it was concluded that selenium was not detected in any of the food grains analysed which include organic and non-organic white rice, brown rice, bajra and wheat. Cadmium was detected only in non-organic wheat. The amount of magnesium was highest in the non-organic bajra. Hence while conducting the diet counselling for the patient the dentist should also consider to evaluate the amount of trace elements intake of the patient as well, as it plays a vital role in functioning of the human body. Also the evaluation of trace elements will help the dentist in counselling and guiding the caries risk patients. The diet counselling and the modification in the diet should be undertaken after keeping in consideration the amounts of trace elements in the diet.

CONFLICT OF INTEREST:
None

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