Betaine Concentration of Common Foods in the US.

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Abstract. Betaine, a choline derivative, is produced in the human body from choline and contributes methyl groups for the conversion of homocysteine to methionine. Elevated levels of plasma homocysteine can be harmful to blood vessels leading to the development of heart disease, stroke, and peripheral vascular disease. Betaine also assists the liver to process lipids and protect against chemical damages. Our objective is to develop the first comprehensive database determining the amount of betaine concentration in a nationally representative sampling of common foods consumed in the United States. Various food items were obtained from 12 – 24 retail outlets using the sampling plan developed for the USDA's National Food and Nutrient Analysis Program (Pehrsson, P. et al. J. Food Comp. Anal 13:379, 2000). Products (530) were analyzed for betaine concentration as purchased or after cooking using liquid chromatography with electrospray ionization – isotope dilution mass spectrometry. Quality assurance methods included the use of duplicate sampling, in-house control methods and standard reference materials. The results showed that of the foods analyzed, wheat bran and wheat germ have the highest concentration of betaine (>1gm/100g). Baked products (33 – 226 mg/100g), spinach, beets, crustaceans and finfish are also good sources of betaine. Meats, poultry, fruits, nuts, and wine are generally not good sources of betaine (<6 mg/100g). Since, baked products like bread, crackers, cookies and tortillas are also consumed in large quantities they are major contributors to betaine intake in the US diet. While alcoholic beverages, such as wine and beer, contain low to moderate levels of betaine, their high consumption rates make them key foods for betaine contribution in the US diet. Data on the betaine content of foods is presently very limited. Availability of the betaine content of foods will help determine the betaine intake of the US population, and facilitate research on the homocysteine/methionine pathway.

Introduction

Betaine has also been studied in clinical trials in the treatment of alcohol- related diseases. The primary stage of alcoholic liver damage is the accumulation of fat in the liver. Betaine, because of its lipotropic effects, has been shown to produce significant improvements in this condition by assisting the liver in processing fats (lipids). Betaine has also been found to protect the liver against hepatotoxins such as ethanol and carbon tetrachloride. Thus, betaine has both lipotropic and hepatoprotective activity in humans (Vos et al, 1009).

•Betaine, a choline derivative also known as trimethylglycine, is produced in the human body from choline and the amino acid glycine. As with folic acid, vitamin B6 and vitamin B12 , betaine may function as a methyl donor and aid in proper liver function, cellular replication, and detoxification reactions. Betaine, along with other nutrients, plays a role in reducing elevated blood levels of homocysteine by facilitating its conversion to methionine. Elevated homocysteine levels can lead to artherosclerosis, stroke, peripheral vascular disease, osteoporosis and optic lens dislocation (Brower et al, 2000). Methylenetetrahydrofolate reductase deficiency, a common inborn error of folate metabolism, occurs in children when homocystinuria is combined with hypomethioninemia resulting in severe developmental delay, seizures, apnea, microcephaly, peripheral neuropathy and coma. Betaine treatment has been shown to be efficient in lowering homocysteine concentrations and in returning methionine to normal levels (Fattal – Valevski et al, 2000) (Fig 1).

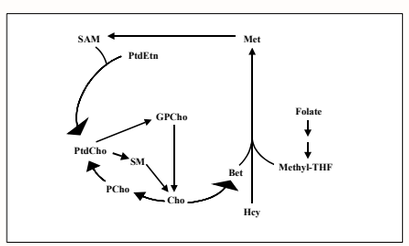

Figure 1 : Metabolic Pathway for homocysteine /methionine pathway. Research has shown that transmthylation metabolic pathways intersect with betaine and folate at the formation of methionine (met) from homocysteine (Hcy). Deficiency of betaine causes methyltetrahydrofolate (methyl - THF) to remethylate homocysteine and increase folate requirements. Similarly, deficiency of folate increases the need for betaine in the liver for methylation of homocysteine. Therefore, adequate availability of betaine in the diet can serve to spare excess folate for methionine formation (Zeisel et al, 2003; Niculescu MD, Zeisel SH, 2002)

Objectives

•To develop the first comprehensive database determining the amount of Betaine concentration in a nationally representative sampling of common foods consumed in the United States.

•To determine the top food contributors of betaine in the US diet using the "Key Foods" approach (Haytowitz et al, 2002)

Method

•Samples of two hundred forty one food items of various types were obtained from 12-24 retail outlets in accordance with the nationwide sampling plan developed for the National Food and Nutrient Analysis Program (Pehrsson, P. et al, 2000).

•The sampling plan was based on a self weighting stratified design. First, the US was divided into four regions, then each region was further divided into three implicit strata from which generalized Consolidated Metropolitan Statistical (gCMSAs) areas were selected (Fig 2). Specific brands of samples were selected based on current market share (amount consumed) and prepared for analysis of betaine.

•Approximately 15% of the analyses were based on samples picked up locally (Chapel Hill, NC). Various cooking methods were used as appropriate. Packaged foods were prepared according to package directions.

•Products were analyzed as purchased or after cooking using liquid chromatography- electrospray ionization- isotope dilution mass spectrometry method (Zeisel et al, 2003).

•Quality assurance was monitored through the use of duplicate sampling, in-house control materials; Standard Reference materials for betaine are not available (Fig 3).

•"Key foods" for betaine contribution were identified based on food consumption survey data collected by USDA (NHANES 1999-2000).

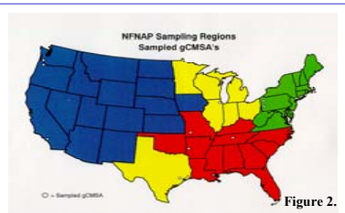

Figure 2.

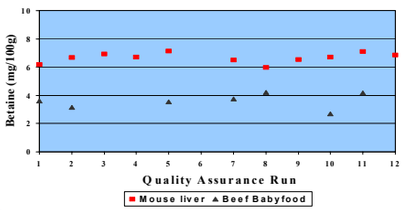

Fig: 3 Quality Assurance is monitored through the use of control materials: Mouse liver homogenate and Beechnut beef baby food. Each data point represents the betaine value for the respective control materials analyzed with each sample batch and is reflective of analytical precision.

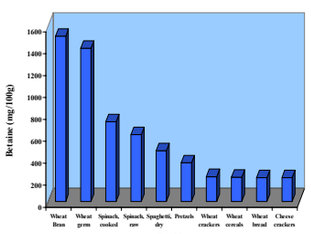

Figure 4: Betaine concentration for the top ten food items analyzed. Total sampling size two hundred and forty one foods. Column height represents the concentration of betaine in each food

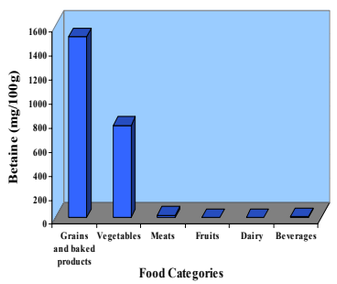

Figure 5: Betaine concentration in foods expressed by Food Categories. One hundred and eighty nine foods were analyzed. Column height represents the highest concentration of betaine within each category.

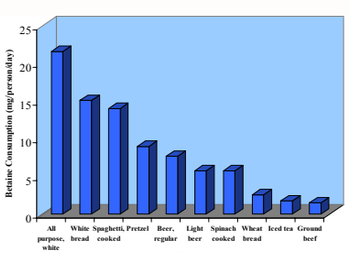

Figure 6: Nationwide consumption of betaine. Data represents the top food contributors of betaine in the US diet based on a sample size of one hundred eighty nine foods.

Results

•Of the two hundred and forty one foods analyzed betaine concentration was the highest in wheat and wheat products.

(>1 gm/100g) (Fig: 4).

•Dry spaghetti, pretzels, cheese crackers, whole wheat bread, beets and all purpose flour are also good sources of betaine (Fig 4).

•Beer, iced tea and ground beef are low to moderate sources of betaine (<6 mg/100g) (Fig: 5).

•Food categories like meats, dairy, fruits and beverages are low in betaine concentration (Fig: 5)

•Based on consumption data, all purpose flour, wheat products, beer, iced tea and ground beef are consumed in large quantities making them key foods for betaine contribution in the US diet (Fig: 6)

Conclusion

•Analytical data on the betaine content of foods is presently very limited. The establishment of a betaine database would provide researchers, consumers, nutrition professionals and government agencies the necessary information for assessing betaine intake in the US diet.

•In order to determine the dietary intake of betaine in the US population, nutrient concentration alone is not sufficient. Due to their extremely high consumption levels, foods relatively low in betaine, such as beer, iced tea and ground beef, become major betaine contributors in the US diet as is evidenced by the betaine key foods list.

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