Available online at **www.ijmrhs.com**

ISSN No: 2319-5886

International Journal of Medical Research & Health Sciences, 2016, 5, 8:22-29

Association between sodium bicarbonate consumption and human health: A systematic review

Yadolah Fakhri[1], Nazak Amanidaz[2], Yahya Zandsalimi[3], Maryam Dadar[4], Ali Moradi[5], Bigard Moradi[6], Leila Rasouli Amirhajeloo[7], Hassan Keramati[8], Athena Rafieepour[9,*]

[1]Food and Cosmetic Health Research Center, Hormozgan University of Medical Sciences, Bandar Abbas, Iran
[2]Environmental Health Research Center, Golestan University of Medical Sciences, Golestan, Iran
[3]Environmental Health Research Center, Kurdistan University of Medical Sciences, Sanandaj, Iran
[4]Razi Vaccine and Serum Research Institute, Agricultural Research, Education and Extension Organization (AREEO), Karaj, Iran
[5]Asadabad Health and Treatment Network, Hamadan University of Medical Sciences, Hamadan, Iran
[6]Department of Health Public, Kermanshah University of Medical Sciences, Kermanshah, Iran
[7]Department of Environmental Health Engineering, School of Public Health, Qom University of Medical Sciences, Qom, Iran
[8]Department of Environmental Health Engineering, School of Public Health, Semnan University of Medical Sciences, Semnan, Iran
[9]Studends Research Office, Shahid Beheshti University of Medical sciences, Tehran, Iran
**Correspondence Email: select916@yahoo.com*

ABSTRACT

Sodium bicarbonate or baking soda is a chemical compound dissolved in water which is widely used as an additive in foods and mineral water and as a medicine. In Iran, due to the introduction of harmful effects of this compound, using it in baking is prohibited. Therefore, we tried to search and evaluate all health effects of using this compound with a systematic review. In this study, all available evidences on the beneficial and harmful effects of sodium bicarbonate were searched. The method was based on systematic study of reputable databases including Embase, Ovid, Scopus, Pubmed and ISI Web of science. Invalid studies were found that shows the relationship of harmful effects of sodium bicarbonate on general health. In addition to that, the studies showed therapeutic aspects and useful effects of this material. Some studies showed the harmful effects of therapeutic using of sodium bicarbonate with high dose that randomly happened. Reviewing of credible studies showed that not only using sodium bicarbonate is not harmful for human health, but also using it as a drug can be useful in treatment and relief of some diseases.

Keywords: Sodium bicarbonate, food material, drinking water, adverse effects, beneficial effects and human health.

INTRODUCTION

Sodium bicarbonate is known as baking soda and baking powder. Molecular mass of this compound is 184.007 g/mole, its density is 2.20 g/cm3 and soluble in water [1]. The LD_{50} (Lethal Dose, 50%) toxicity of this substance in mouse is 4.2 g/kg. This substance degrades into carbon dioxide, sodium carbonate and water and with gas production; carbon dioxide causes a faster fermentation [2,3]. Thus, this compound is used to bake cakes and bread. In Iran, despite laws preventing the use of sodium bicarbonate, but it is used in some bakeries and cake and pastry centers [4,5]. In recent decades, some studies in Iran have shown that using sodium bicarbonate in the bread causes

damage to general health [5,6] . Such these preventing rules have been approved in Iran while in Europe and in the United States of America, this compound is an approved material which is widely used in foods and medicines [3, 7-8]. Some studies have shown that the use of sodium bicarbonate in the flour fermentation process causes that the available phytic acid in the flour enters into bread or pastry without break down and decreases the absorption of metals such as iron, zinc, calcium and etc. [8-10]. Also, some studies in Iran have shown that using sodium bicarbonate will reduce the serum levels of iron and calcium [11]. Also official and unofficial websites have mentioned the increased absorption of heavy metals, increasing waste of bread and bad taste of bread [12]while some studies have pointed to ineffectiveness of it on the bread quality [13]. On the other hand, some studies have shown the useful effect of using sodium bicarbonate on athletic performance [14-17]. Use of sodium bicarbonate along with bromelain and some other anti-acids in the treatment of indigestion [18,19]and calcium and sodium bicarbonate is used to treat hyperkalemia [20-22]. Beneficial or harmful effects that are dose-dependent sodium bicarbonate therefore, we attempted to do a detailed assessment of the effects of this chemical compound on human health by a systematic review on the credible studies which have evaluated the health effects of using sodium bicarbonate in food (bread, pastry and etc.), drinking water and medicine on human.

MATERIALS AND METHODS

The present study was a systematic review of the association between Sodium bicarbonate consumption and human health. To find the conducted studies in Iran and the world, were used the databases of Pubmed, Scopus, Ovid, Embase and ISI Web of Science.

1.2. The criteria of selection and evaluating quality of studies

At first, a list of titles and abstracts of all available studies in databases mentioned by three researchers (Ya.F, Ha.K, At.R) was developed to avoid biased investigators. Related titles were examined independently then search in studies which were published between the dates 1990 to 2016, were done. Searching was done for two weeks from 23.01.2016 to 07.02.2016, then the related were evaluated initially as blind and independently were entered into the research process. Similar studies were excluded. The main inclusion criteria of different to this study were referring to the Sodium bicarbonate consumption and human health. The researches which were not the primary studies or were about treatment, determining the clinical characteristics, clinical decision making and evaluations not Sodium bicarbonate consumption and human health. In the second phase, the abstracts of different selected studies were evaluated by a researcher using Strengthening the reporting of observational studies in epidemiology (STROBE) check list which is a standard check list. This check list contains 43 various sections and aspects of methodology including sampling methods, measuring variables, statistical analysis and evaluates the objectives of studies [23]. In this check list, the minimum and maximum scores were considered as 40 and 45, respectively. Finally, the top paper which had been obtained at least 40 score given to the questions of the check list were entered to review.

2.2. Data extraction

In this study, 14 studies which almost a same methodology was used in all of them and were performed from 1992 to 2015, were evaluated. The required important information to analyze data including the information related to the topic, title and methodology such as method of studies, type of studies, location of studies, date studies, target population, side effects and outcome were gathered.

RESULTS

By searching in data sources of Ovid, Scopus, Embase, ISI Web of Science and Pubmed using the independent study and strategy, totally 1954 were obtained. After reviewing their titles by two persons, the studies were selected which pointed out the presence and absence of side effects and benefits in humans that the number rose to 921 . At this stage, review and case reports were removed and the number of articles were reached to 284. Then, the studies that referred to sodium bicarbonate in human, were selected for a detailed studies with a total number of 14 articles (Figure 1). No study was not found in this study that examined the harmful effects of using sodium bicarbonate on human health. The obtained evidences included observational studies and clinical trials and more in the field of treatment and useful effects of this compound. According to studies that were done on the selected, the effects of sodium bicarbonate can be divided into cardiovascular, gastrointestinal, hematologic, pulmonary, renal, oncology, endocrinology and metabolism, electrolyte and functional categories. Most of studies indicate that sodium bicarbonate is ineffective on these cases or even has a beneficial effect. The complications which have been

reported, included gastrointestinal and partial electrolyte symptoms in the therapeutic dose. Only in some case report studies, it was noted to the using complications of sodium bicarbonate in high dose.

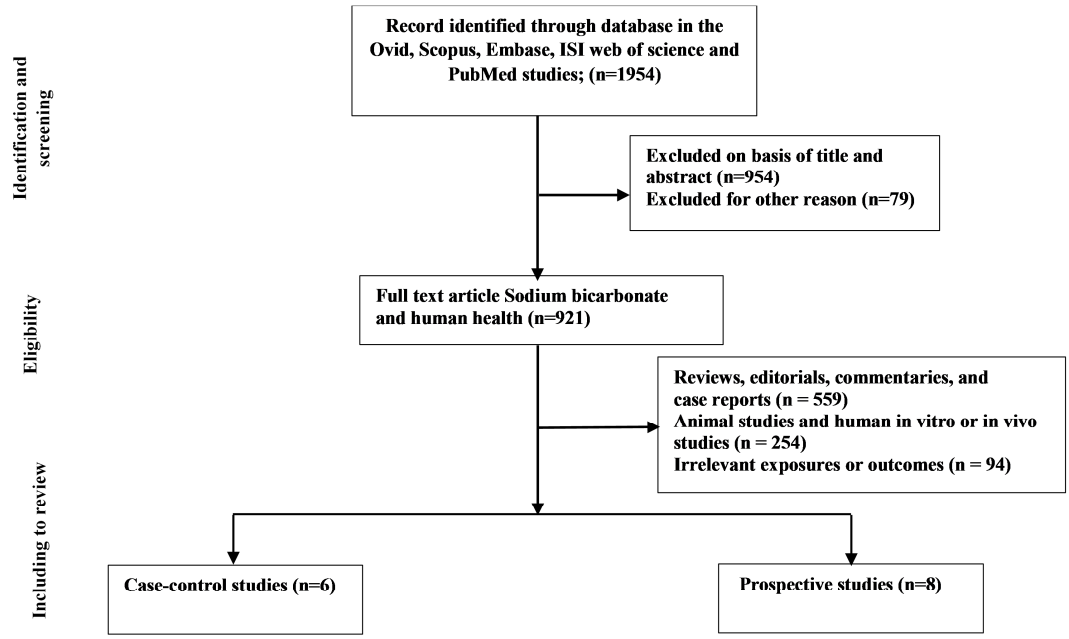

Figure 1. The results of study in database of Ovid, Scopus, Embase, ISI Web of Science and Pubmed using studies strategy

Table 1. Content analysis of inserted studies in the systematic review

Article No.	First author (Date)	Type of studies	Target population	Side effects compared to the control group	Outcome
1	Schorr et al(1996)	Prospective	21 healthy women and men	Causes an increased urinary sodium excretion, decreased urinary calcium excretion, hypotension at the rest, no effect on 24-hour blood pressure	There is no difference between blood glucose, insulin and blood lipids of two groups (p value<0.001)
2	Verove et al (2002)	prospective	18 patients with renal insufficiency	No patient with the complications such as fluid retention, weight changes and blood pressure changes	Serum albumin and pre-albumin levels after correction of acidosis were clearly increased
3	Brady et al (1998)	prospective	166 patients with chronic hemodialysis	No complications including hypertension before dialysis or weight gain during dialysis were seen. Weight loss was even seen during dialysis	Increased serum bicarbonate level was not associated with any complication and is well tolerated. No difference between serum albumin and potassium levels was seen (p value<0.01)
4	Tamura et al (2004)	Case control	10 patients with colorectal cancer	No difference in the incidence of diarrhea, anorexia and alopecia. The rate of weight loss in the group receiving sodium bicarbonate was a little higher	Physical condition and amount of pleasure from food in the group receiving sodium bicarbonate were better and vomiting was lower
5	Schoppen et al (2004)	Case control	18 postmenopausal women who did not use any medicines	No change was occurred in the blood pressure	Decrease in total cholesterol, LDL, sVCAM-1, sICAM-1, an indicator of cardiovascular disease and fasting blood sugar increased HDL (p value<0.001)
6	Swartz et al (1992)	prospective	157 patients who are candidates of colonoscopy	In half of cases, patients experience nausea, abdominal fullness, abdominal cramps and vomiting which were mild and transient	-
7	Brito-Ashurst et al (2009)	Case control	129 patients with renal insufficiency with low level of serum	A clear difference in terms of hospitalization due to congestive heart failure, hypertension and	Causes slow progression in renal insufficiency and improvement of nutritional status

			bicarbonate	edema with need to severe treatment was not seen	RR=0.13, (CI: 0.04-0.4)
8	Cameron et al (2010)	Case control	25 male athletes	Causes an increase in the incidence of bloating, abdominal pain, diarrhea, nausea and blood lactate levels	No difference was seen in the performance of athletes receiving sodium bicarbonate supplementation compared to the control group
9	Moreno et al (2006)	Case control	24 patients with gastrointestinal cancer	No side effect related to sodium bicarbonate consumption was reported	-
10	Ori et al (2015)	prospective	13 patients with chronic renal disease (12 women and 1 man)	It is followed by decreased urea, potassium, pH and increased serum bicarbonate	Improvement of metabolic acidosis with a decrease in IL-10 secretion, no change in weight, pressure, creatine, sodium, calcium, PTH, Hg and CRP was seen (P value<0.001)
11	Wang et al (2015)	prospective	109 patients with high level of serum potassium (hyperkalemia)	No side effect related to consumption of sodium bicarbonate was seen	Increased efficacy of CRP in the patients. Men:OR:1.99 (CI:1.33-2.96) for women: OR:2.47 (CI:1.22-5)
12	Perez Granados et al (2010)	Case control	80 young volunteers without cardiac disease	Decreased systolic blood pressure	Decreased LDL, reduced total cholesterol compared to the control group (p value<0.001)
13	Wu et al (2010)	prospective	9 tennis players	No side effect related to sodium bicarbonate consumption was reported	Reduced lactate and increased pH in the blood compared to the control group (p value<0.05)
14	Mer et al (2013)	prospective	30 swimmers	No side effect related to sodium bicarbonate consumption was reported	Increased in the speed of swimmers compared to the control (p value<0.001)

DISCUSSION

In this study strategy were studies for finding the beneficial and harmful effects of sodium bicarbonate and no studies were found to point to the harmful effects of sodium bicarbonate in food materials on human health. But in the meantime, some beneficial effects have been reported that will be outlined below. Some studies which have only evaluated the effect of sodium bicarbonate on absorption of other materials and pointed only to treatment and beneficial effects of it and not the complications of sodium bicarbonate. Some studies were not acceptable in terms of quality, such as case control studies and clinical trial in their results was observed. Many studies have shown the inhibitory effects of phytic acid on the absorption of essential elements such as iron, calcium and zinc [8, 24-28].

Various methods cause a decrease in the available phytic acid in cereals which is included membrane separation, milling and fermentation [29-32]. According to the conducted systematic review studies, no evidences for the inhibitory effect of sodium bicarbonate on phytic acid degradation were observed. On the other hand, other studies showed that without the addition of any yeast material or sodium bicarbonate and only with natural fermentation, the most part of phytate degradation (almost 50%) is done in the first 15 minutes and no considerable change was observed within 2 hours [33,34]. In regard to cardiovascular system, it is reported that consumption of water rich by sodium bicarbonate (32.5 mmol/l of HCO3 in amount of 1.5 liters in 4 weeks) with a low-salt diet had no effect on blood pressure in healthy individuals [35]. Also, 2094.4 mg/l of sodium bicarbonate in 1 liter per day for 2 months can reduce heart disease index [36]. Also, consumption of one liter of mineral water per day with a concentration of 48 mmol and 35 mmol for 2 months causes decreased LDL-cholesterol, total cholesterol and blood pressure compared to the control group. In fact, this study showed that sodium bicarbonate consumption reduces the risk of cardiac diseases in young men and women [37]. Also, consumption of calcium and sodium bicarbonate in 109 hyperkalemia patients (serum potassium level>6.5 meq/L) results in better performance of CPR [38]. The average of blood pressure in patients with renal insufficiency by using 3-6 gr of sodium bicarbonate per day for 6 months has no difference compared to the control group and no fluid retention was reported [39]. In relation to gastrointestinal side effects, using this compound in high doses can cause nausea, bloating and abdominal discomfort [4] and vomiting and abdominal cramps [40]. It is interesting that this material in patients with gastrointestinal cancer causes reduced nausea and diarrhea resulted from chemotherapy [40,41]. In consumption of sodium bicarbonate as a supplement in athletes (0.3 g/kg), lactate concentration and digestive symptoms such as cramp and abdominal pain, diarrhea, bloating and nausea in the receiver group were clearly higher than the control group [42]. Another study showed that sodium bicarbonate consumption in young swimmers can increase their performance compared to the control group by regulation of blood buffering power [15]. A series of mild gastrointestinal complications such as diarrhea, nausea and vomiting had been attributed to sodium bicarbonate in the cholera vaccine [43]. In patients with

gastrointestinal cancer and renal failure, using this compound has no effect on hemoglobin levels and anemia [44,45]. In conjunction with pulmonary and renal effects, it increases urinary sodium excretion and makes the progression of renal disease slow [35,46]. Also, taking it as a supplement in the patients with renal failure did not change blood urea nitrogen and creatinine levels [47]. But, renal thromboplastic activity was clearly reduced that indicate hemostatic imbalance. Also, pulmonary thromboplastic activity had a change [48]. In relation to metabolic effects in healthy people, consumption of water rich in sodium bicarbonate creates no change in blood glucose and insulin, oral glucose and lipid tolerances [35,49]. Also, it causes a decrease in fasting blood glucose, total serum cholesterol, LDL and cardiovascular risk index and an increase in HDL in healthy postmenopausal women [50]. In patients with renal failure, blood fasting glucose level was reduced and blood fasting insulin level was increased compared to the control group [51]. Also, this compound has no effect on calcium and phosphorus concentration, but increased the serum potassium concentration and serum albumin level clearly and made the nutritional status of these patients better [44]. In athletes, consumption of sodium bicarbonate in 9 tennis players (0.3 g/kg) causes an increase in their performance through reducing of blood lactate [52] as well as using sodium bicarbonate (0.3 g/kg) in 30 male swimmers causes an increase in their speed compared to the other groups (consumer of intracellular buffer beta-alanine and placebo) [53]. In relation to gastrointestinal disease, consumption of sodium bicarbonate not only had no harmful effects but also reduced improvement of patients through metabolic acidosis [54]. Since some studies have shown that IL-10 can have negative effects on cancer resistance hence the effect of sodium bicarbonate consumption on IL-10 secretion and cancer resistance can be evaluated [55]. Although, the aim of this study was to find credible evidences, we found a cross-sectional and case reports during this study that have noted to the side effects of sodium bicarbonate consumption in high doses. However, these cases have been occurred in very high doses that due to lack of control group, it cannot only be related to sodium bicarbonate. These items including stomach rupture following a long-term use of high dose of sodium bicarbonate [56,57], metabolic alkalosis [58], and cardiac arrhythmia due to overdose has been reported [59].

CONCLUSION

Not only evidences about the harmful effects of using sodium bicarbonate on general health were not found, but also many benefits of using this compound in therapeutic dose have been reported. In relation to the case reports that had referred to the complications of therapeutic doses of using this material, any chemical compound in the high dose use can be fatal. Everything is toxin and nothing is without toxin and only the dose makes a thing non-toxic.

Acknowledgements
Students Research office of Shahid Beheshti University of Medical Sciences was supports the financial of this research (Code:2656, Date:2016/03/01).

REFERENCES

[1] Sircus M. Sodium Bicarbonate: Lulu.com; 2014.
[2] Kawas J, García-Castillo R, Garza-Cazares F, Fimbres-Durazo H, Olivares-Saenz E, Hernandez-Vidal G, et al. Effects of sodium bicarbonate and yeast on productive performance and carcass characteristics of light-weight lambs fed finishing diets. Small Ruminant Research. 2007;67(2):157-63.
[3] SIDS O. Sodium bicarbonate. UNEP Publications; 2002.
[4] GhR JK, Nabizadeh R, GhA P. A Survey on Baking Soda Elimination from Iranian Flat Breads in Bakeries of Islamshahr City in 2005. Toloo e Behdasht. 2006;5:24-34.
[5] Malakouti M. Towards improving the quality of consumed breads in Iran: A review. 2011.
[6] Sodium Bicarbonate hazards. Nutrition and Health database Available at:http://www.behsite.ir/content/articles/314/1875 (Accessed Aygust 20, 2011).
[7] Kloss L, Meyer JD, Graeve L, Vetter W. Sodium intake and its reduction by food reformulation in the European Union—A review. NFS Journal. 2015;1:9-19.
[8] Norhaizan M, Nor Faizadatul A. Determination of phytate, iron, zinc, calcium contents and their molar ratios in commonly consumed raw and prepared food in Malaysia. Malaysian journal of nutrition. 2009;15(2):213-22.
[9] Sharpe LM, Peacock WC, Cooke R, Harris RS. The effect of phytate and other food factors on iron absorption. Journal of Nutrition. 1950;41(3):433-46.
[10] Bohn L, Meyer AS, Rasmussen SK. Phytate: impact on environment and human nutrition. A challenge for molecular breeding. Journal of Zhejiang University Science B. 2008;9(3):165-91.

[11] Farahani H, Modaresi H. Study on the effect of Sodium Bicarbonate in serum Iron TIBC on rats. Arak Medical University Journal (Rahavard Danesh). 2000;3:35-40.
[12] Ahankoubnegad MR, Iran university of medical sciences (Accessed August 10, 2011).
[13] Faridi H, Finney P, Rubenthaler G. Effect of soda leavening on phytic acid content and physical characteristics of Middle Eastern breads. Journal of Food Science. 1983;48(6):1654-8.
[14] Artioli GG, Gualano B, Coelho DF, Benatti FB, Gailey AW, Lancha Jr AH. Does sodium-bicarbonate ingestion improve simulated judo performance? International journal of sport nutrition and exercise metabolism. 2007;17(2):206.
[15] Zajac A, Cholewa J, Poprzecki S, Waskiewicz Z, Langfort J. Effects of sodium bicarbonate ingestion on swim performance in youth athletes. Journal of sports science & medicine. 2009;8(1):45.
[16] Peart DJ, Siegler JC, Vince RV. Practical recommendations for coaches and athletes: a meta-analysis of sodium bicarbonate use for athletic performance. The Journal of Strength & Conditioning Research. 2012;26(7):1975-83.
[17] Afman G, Garside RM, Dinan N, Gant N, Betts J, Williams C. Effect of carbohydrate or sodium bicarbonate ingestion on performance during a validated basketball simulation test. International journal of sport nutrition and exercise metabolism. 2014.
[18] Bertoni M, Oliveri F, Manghetti M, Boccolini E, Bellomini MG, Blandizzi C, et al. Effects of a bicarbonate-alkaline mineral water on gastric functions and functional dyspepsia: a preclinical and clinical study. Pharmacological research. 2002;46(6):525-31.
[19] Cuomo R, Grasso R, Sarnelli G, Capuano G, Nicolai E, Nardone G, et al. Effects of carbonated water on functional dyspepsia and constipation. European journal of gastroenterology & hepatology. 2002;14(9):991-9.
[20] An JN, Lee JP, Jeon HJ, Kim DH, Oh YK, Kim YS, et al. Severe hyperkalemia requiring hospitalization: predictors of mortality. Crit Care. 2012;16(6):R225.
[21] Soar J, Perkins GD, Abbas G, Alfonzo A, Barelli A, Bierens JJ, et al. European Resuscitation Council Guidelines for Resuscitation 2010 Section 8. Cardiac arrest in special circumstances: Electrolyte abnormalities, poisoning, drowning, accidental hypothermia, hyperthermia, asthma, anaphylaxis, cardiac surgery, trauma, pregnancy, electrocution. Resuscitation. 2010;81(10):1400-33.
[22] Hazinski MF, Field JM. 2010 American Heart Association Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science. Circulation. 2010;122(Suppl):S639-S946.
[23] Towo E, Mgoba C, Ndossi GD, Kimboka S. Effect of phytate and iron-binding phenolics on the content and availability of iron and zinc in micronutrients fortified cereal flours. African Journal of Food, Agriculture, Nutrition and Development. 2006;6(2).
[24] Lazarte CE, Carlsson N-G, Almgren A, Sandberg A-S, Granfeldt Y. Phytate, zinc, iron and calcium content of common Bolivian food, and implications for mineral bioavailability. Journal of Food Composition and Analysis. 2015;39:111-9.
[25] Armah SM, Boy E, Chen D, Candal P, Reddy MB. Regular consumption of a high-phytate diet reduces the inhibitory effect of phytate on nonheme-iron absorption in women with suboptimal iron stores. The Journal of nutrition. 2015;145(8):1735-9.
[26] Kruger J, Taylor JRN, Oelofse A. Effects of reducing phytate content in sorghum through genetic modification and fermentation on in vitro iron availability in whole grain porridges. Food Chemistry. 2012;131(1):220-4. doi: http://dx.doi.org/10.1016/j.foodchem.2011.08.063.
[27] Lönnerdal B, Sandberg A-S, Sandström B, Kunz C. Inhibitory effects of phytic acid and other inositol phosphates on zinc and calcium absorption in suckling rats. The Journal of nutrition. 1989;119(2):211-4.
[28] Baye K, Guyot J-P, Icard-Vernière C, Rochette I, Mouquet-Rivier C. Enzymatic degradation of phytate, polyphenols and dietary fibers in Ethiopian injera flours: Effect on iron bioaccessibility. Food chemistry. 2015;174:60-7.
[29] Hui YH, Meunier-Goddik L, Josephsen J, Nip WK, Stanfield PS. Handbook of Food and Beverage Fermentation Technology: CRC Press; 2004.
[30] Magala M, Kohajdová Z, Karovičová J. Degradation of phytic acid during fermentation of cereal substrates. Journal of Cereal Science. 2015(61):94-6.
[31] Chen L, Vadlani PV, Madl RL, Gibbons W. Degradation of Phytic Acid and Soy Protein in Soy Meal via Co-fermentation of Aspergillus oryzae and Aspergillus ficuum. Journal of the American Oil Chemists' Society. 2015:1-6.
[32] Sakai H, Iwai T, Matsubara C, Usui Y, Okamura M, Yatou O, et al. A decrease in phytic acid content substantially affects the distribution of mineral elements within rice seeds. Plant Science. 2015;238:170-7.
[33] Buddrick O, Jones OA, Cornell HJ, Small DM. The influence of fermentation processes and cereal grains in wholegrain bread on reducing phytate content. Journal of Cereal Science. 2014;59(1):3-8.

[34] Mahgoub SE, Elhag SA. Effect of milling, soaking, malting, heat-treatment and fermentation on phytate level of four Sudanese sorghum cultivars. Food chemistry. 1998;61(1):77-80.
[35] Schorr U, Distler A, Sharma AM. Effect of sodium chloride-and sodium bicarbonate-rich mineral water on blood pressure and metabolic parameters in elderly normotensive individuals: a randomized double-blind crossover trial. Journal of hypertension. 1996;14(1):131-6.
[36] Sodium Bicarbonate. UNEP Publications. SIDS Initial Assessment Report For SIAM 15; Boston, U., 22-25 October 2002.
[37] Pérez-Granados AM, Navas-Carretero S, Schoppen S, Vaquero MP. Reduction in cardiovascular risk by sodium-bicarbonated mineral water in moderately hypercholesterolemic young adults. The Journal of nutritional biochemistry. 2010;21(10):948-53.
[38] Wang C-H, Huang C-H, Chang W-T, Tsai M-S, Yu P-H, Wu Y-W, et al. The effects of calcium and sodium bicarbonate on severe hyperkalaemia during cardiopulmonary resuscitation: A retrospective cohort study of adult in-hospital cardiac arrest. Resuscitation. 2015.
[39] Verove C, Maisonneuve N, El Azouzi A, Boldron A, Azar R. Effect of the correction of metabolic acidosis on nutritional status in elderly patients with chronic renal failure. Journal of Renal Nutrition. 2002;12(4):224-8.
[40] Tamura T, Yasutake K, Nishisaki H, Nakashima T, Horita K, Hirohata S, et al. Prevention of irinotecan-induced diarrhea by oral sodium bicarbonate and influence on pharmacokinetics. Oncology. 2004;67(5-6):327-37.
[41] Veeck EB, Trucci VM, Morosolli ARC. Current strategies for the management of oral mucositis induced by radiotherapy or chemotherapy. 2009.
[42] Cameron SL, McLay-Cooke RT, Brown RC, Gray AR, Fairbairn KA. Increased blood pH but not performance with sodium bicarbonate supplementation in elite rugby union players. International journal of sport nutrition and exercise metabolism. 2010(20):307-21.
[43] Tacket CO, Losonsky G, Nataro JP, Cryz SJ, Edelman R, Fasano A, et al. Safety and Immunogenicity of Live Oral Cholera Vaccine Candidate CVD 110, a ΔctxA ctxAzot zotace Derivative of El Tor Ogawa Vibrio cholerae. Journal of Infectious Diseases. 1993;168(6):1536-40.
[44] de Brito-Ashurst I, Varagunam M, Raftery MJ, Yaqoob MM. Bicarbonate supplementation slows progression of CKD and improves nutritional status. Journal of the American Society of Nephrology. 2009;20(9):2075-84.
[45] Shavit L, Korenfeld R, Lifschitz M, Butnaru A, Slotki I. Sodium Bicarbonate versus Sodium Chloride and Oral N-Acetylcysteine for the Prevention of Contrast-Induced Nephropathy in Advanced Chronic Kidney Disease. Journal of interventional cardiology. 2009;22(6):556-63.
[46] Merten GJ, Burgess WP, Gray LV, Holleman JH, Roush TS, Kowalchuk GJ, et al. Prevention of contrast-induced nephropathy with sodium bicarbonate: a randomized controlled trial. Jama. 2004;291(19):2328-34.
[47] Robey I, Lopez A, Roe D. Safety and Tolerability of Long-Term Sodium Bicarbonate Consumption in Cancer Care. J Integr Oncol. 2015;4(128):2.
[48] Akbay TT, Emiroglu A, Gul N, Eren N, Yarat A. Effects of sodium bicarbonate induced blood pH change on oxidant status and thromboplastic activity of the kidney and lung. Asian Journal of Chemistry. 2008;20(4):3182.
[49] Tripathi M, Santra A, Chaturvedi O, Karim S. Effect of sodium bicarbonate supplementation on ruminal fluid pH, feed intake, nutrient utilization and growth of lambs fed high concentrate diets. Animal feed science and technology. 2004;111(1):27-39.
[50] Schoppen S, Pérez-Granados AM, Carbajal Á, Oubiña P, Sánchez-Muniz FJ, Gómez-Gerique JA, et al. A sodium-rich carbonated mineral water reduces cardiovascular risk in postmenopausal women. The Journal of nutrition. 2004;134(5):1058-63.
[51] Mak RH. Effect of metabolic acidosis on hyperlipidemia in uremia. Pediatric Nephrology. 1999;13(9):891-3.
[52] Wu C-L, Shih M-C, Yang C-C, Huang M-H, Chang C-K. Sodium bicarbonate supplementation prevents skilled tennis performance decline after a simulated match. J Int Soc Sports Nutr. 2010;7:33.
[53] Mero AA, Hirvonen P, Saarela J, Hulmi JJ, Hoffman JR, Stout JR. Effect of sodium bicarbonate and beta-alanine supplementation on maximal sprint swimming. Journal of the International Society of Sports Nutrition. 2013;10(1):52.
[54] Ori Y, Zingerman B, Bergman M, Bessler H, Salman H. The effect of sodium bicarbonate on cytokine secretion in CKD patients with metabolic acidosis. Biomedicine & Pharmacotherapy. 2015;71:98-101.
[55] Ng TS, Britton GJ, Hill EV, Verhagen J, Burton BR, Wraith DC. Regulation of adaptive immunity; the role of interleukin-10. Frontiers in immunology. 2013;4.
[56] Ishikawa T, Miyaishi S, Yamamoto Y, Yoshitome K, Inagaki S, Ishizu H. Sudden unexpected death due to rupture of the stomach. Legal Medicine. 2003;5(1):60-4.
[57] Libeer F, Vanhamel N, Huyghe M, Verlinden E. Spontaneous gastric rupture in non-neonatal children: A case report. Acta chirurgica Belgica. 2007;107(5):560.

[58] Stephens TJ, McKENNA MJ, Canny BJ, Snow RJ, McCONELL GK. Effect of sodium bicarbonate on muscle metabolism during intense endurance cycling. Medicine and science in sports and exercise. 2002;34(4):614-21.
[59] Caponnetto S, Pastorini C, Masperone M. [Attack of ventricular fibrillation type" torsade de point" due to excess ingestion of sodium bicarbonate (author's transl)]. Giornale italiano di cardiologia. 1973;4(2):211-6.