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Dietary Oxalates and the Urinary System

Farouk El-Sabban*

Department of Food Science and Nutrition, College of Life Sciences, Kuwait University, Kuwait City, Kuwait

***Corresponding Author:** Farouk El-Sabban, Professor of Nutrition and Physiology, Department of Food Science and Nutrition, College of Life Sciences, Kuwait University, Kuwait City, Kuwait.

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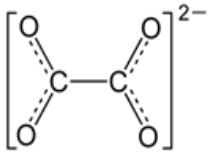
Oxalate, known chemically as ethanedioate, has the chemical formula of C2O2−4 that can also be written as (COO)2−2 – with the following structure:



The term oxalates is most commonly referred to salts of oxalic acid, such as sodium oxalate ($Na_2C_2O_4$) and dimethyl oxalate $(CH_3)_2C_2O_4$). Metal ions can form insoluble compounds such as in the case of calcium oxalate, which is the major constituent of kidney stones.

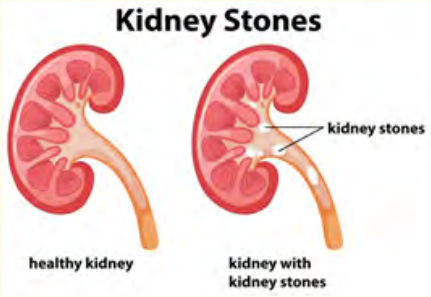
Sources of oxalates in the human body are basically dietary and mostly come from consumed plant-type foods. However, it should be noted that oxalates can also be formed endogenously in the liver from some amino acids and from some carbohydrates. Considerable contents of oxalates are found in many commonly-consumed food items – such as fruits, vegetables, grains, and nuts. Plant food items contain both soluble and insoluble oxalates. There are different methods for determining the soluble and insoluble oxalates [1], and such present compounds are expressed as a number in mg per 100g of the plant material. Oxalates are also found in commonly-consumed beverages, such as tea and coffee, and the content is expressed as the determined number in mg per 240 ml (cup) of prepared beverage.

The content of oxalates in foods of plant sources vary widely among such items. Reported values for the content of oxalates in vegetables (mg/100g) were the highest for rhubarb (124 - 1360) and spinach (300-1260), followed by carrots (500). Other common vegetables were low in their oxalate content – with equal values for broccoli and eggplant (190) and for potatoes and tomatoes (50) and a value of 20 for kale [2]. Soybeans were reported to have a content of 69 mg/100 g and rice has a low value of 21 [3]. Oxalate contents of commonly-consumed fruits were on the low side – ranging from 4 mg for grapes and pears to black plums and mangoes in the middle (about 20) and with 31 mg for strawberry [4]. Among nuts, the contents of oxalates varied considerably – with 49 mg for pistachios, 140 mg for peanuts, 220 mg for hazelnuts, 260 for cashews, and a high value of 470 for almonds [5]. Many values for oxalate contents in tea and coffee were reported in the literature, which seem to be dependent on the source, the method of production, and the method of preparation. However, on a relative basis, black tea has more oxalates than green tea and different kinds of teas have higher oxalate contents than that of coffee [6]. It has been estimated that the range of the daily dietary oxalate intake per person is 50 - 170 mg [7].

The urinary system is composed of the two kidneys - each kidney has a tube known as the ureter and both ureters lead to the urinary bladder. The bladder connects to a tube known as the urethra, where urine is excreted through. The urinary system has different functions in the body – however, its main function is to get rid of metabolic wastes. In relation to oxalates, formation of stones in the urinary system

has the general term known as "urolithiasis". Such a term includes the formation of stones in the kidney (nephrolithiasis), in the ureters (ureterolithiasis), and "cystolithiasis" for those in the bladder [8].

Excretion of oxalates in the body is via the urinary system. It has been estimated that the median urinary excretion values in men and women are about 39 and 27 mg/day, respectively [9]. If excretion of oxalates in urine is insufficient, the oxalate level in plasma increases. If accumulation of oxalates continues to reach the point of spontaneous crystallization, calcium oxalate deposits are formed in the urinary system and in other locations in the body as well – a process known as oxalosis. A good example of such is the formation of oxalate deposits in the synovial spaces of joints – which lead to a condition known as oxalate arthritis [10].



Source: *Google Images [11].*

Nephrolithiasis is a painful disease and could be life threatening if it gets aggravated. Statistics showed that kidney and renal stones are present in many parts of the world and its incidence is on the rise. Recent data in the USA revealed that the number of kidney stone cases increased from 6.3 to 10.5 % in men and from 4.1 to 7.1% in women since 1994 [12]. This study also indicated that kidney stone disease cases were more common in obese than in normal weight persons. Thus, this emphasizes the impact of food and nutrition on the incidence of such a disease condition. Another study Pakistan showed that the highest prevalence of kidney stone disease in males and females was in the age groups of 40 - 49 and 30 - 39, respectively [13]. This study also confirmed that prevalence of this disease is higher in men than in women.

The basic and most significant advice is for all individuals to follow recommended nutritional guidelines for keeping healthy [14]. As dietary oxalates play a significant role in stone formation in the urinary system, it is extremely important to observe some food and dietary measures to lessen the probability of suffering from such a disease. There is a consensus by reputable authorities [15-18] on such considerations that need to be followed to protect and/or lessen the probability of urinary stones – which include, but not limited to: 1) having moderate intake of oxalate-rich food items, 2) drinking enough water for the body to be properly hydrated, 3) reducing intake of animal protein, 4) ensuring an intake of enough calcium, 5) reducing intake of sodium, and 6) drinking enough of juices that contain citric acid. Another measure involves reducing the consumption of sugar-containing soft drinks and drinks of high sugar content, as such were associated with high risk for kidney stone formation [19]. Additionally, it seems that boiling of green vegetables can reduce the oxalate content more than steaming.

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