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Determination of ascorbic acid content in some brands of vitamin C tablets

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Abstract

This research was conducted due to the importance of vitamin c to health and due to presence of many counterfeit drugs in the market and as a result two questions arise: Do we take a low dose? or overdose of vitamin C from drug supplements?
This research was conducted on selected brands of Vitamin C tablets. five brands of vitamin C tablets were purchased from Libyan pharmacies located at El-Ajelalat and Sabratha cities. and the percentage of Ascorbic acid content determined using titration method.
The results showed that samples 1, 2, 3 and 5 failed to fulfill the requirement of British pharmacopoeia of ascorbic acid content.
Samples 1, 2 and 3 are less than the required percentage, sample 5 was higher than the permissible percentage. while sample 4 contains percentage of ascorbic acid that fit with permissible level according to the British Pharmacopoeia. The results were as follows: 92%, 92%, 93% 98%, 124% for samples 1, 2, 3, 4 and 5, respectively.
Keywords: Vitamin C, tablets, titration method, ascorbic acid.

الملخص

تم اجراء هذا البحث نظرا لأهمية فيتامين سي للصحة، ونظرا لوجود العديد من الادوية الغير صالحة والمغشوشة في الأسواق، ومن هنا يبرز سؤلان مهمان:

هل نحن نتحصل على جرعة منخفضة؟ ام جرعة زائدة على الحد المطلوب من فيتامين سي من المكملات الدوائية؟

هذا البحث أجري على عينات مختارة من حبوب فيتامين سي من شركات مختلفة.

خمسة أنواع من حبوب فيتامين سي تم شراؤها من صيدليات ليبية من مدينتي العجيلات وصبراتة.

وتم تعيين نسبة حمض الاسكوربييك في العينات باستخدام المعايرة.

النتائج أوضحت فشل العينات 1,2,3 و5 في اختبار نسبة حمض الأسكوربيك.

حيث كانت العينات 1,2,3 اقل من النسبة المطلوبة بينما العينة رقم 5 كانت اعلى من الحد المسموح.

في حين كانت العينة رقم 4 هي الأفضل حيث كان محتوى حمض الأسكوربيك فيها ضمن الحد المطلوب وفقا لدستور الادوية البريطاني الذي ينص على ألا يكون تركيزه أقل من 95% وألا يتجاوز 107.5%.

النتائج كانت كالتالي: 92%، 92%، 93% ، 98%، 124% للعينات 1، 2، 3، 4، و5 على التوالي.

Introduction

Vitamin c is water soluble substance also known as ascorbic acid.It was identified in the twentieth century during the search for the substances that causes scurvy, if it is deficient [(1)].

Scurvy was initially described as a dietary deficiency caused by a lack of eating fresh vegetables and fruits. Where the rise in its average in northern Europe was observed in the winter season, when fresh vegetables and fruits are not available and It was noted from clinical results that patients have been recovered by drinking lemon juice [(2)]. The human body cannot synthesis vitamin C due to mutation in the DNA coding of gulonolactone oxidase which is the main enzyme responsible for ascorbic acid synthesis, so the body's needs for the vitamin c are obtained from a diet rich in vitamin c and supplements [(3)]. Vitamin C is found in many natural sources, such as fresh fruits and vegetables. Richest sources of ascorbic acid including Indian gooseberry and citrus fruits like lemons, oranges, tomatoes, potatoes, green and red peppers, and kiwi, Strawberries, and green leafy vegetables like broccoli. Some animals like guinea pigs, fishes and birds can synthesize vitamin C and it is concentrated in the liver **[(4)].** Vitamin c is important to make collagen that is which the necessary protein to make skin, cartilage, tendons, ligaments and blood vessels. It is also important for healing of

wounds and health of bones and teeth, where Vitamin C is an essential factor for the hydroxylation of proline , co-factor during collagen processing, activation of pro-collagen messenger RNA, inhibition of matrix metalloproteinase (MMPs) that are responsible for collagen fibers degradation and fibroblast activation intended for new and proper collagen formation [5]. Vitamin C functions depend mainly on its main character as anti-oxidant and the free radicals that result from normal metabolism, its antioxidant effect is by electron donation process where vitamin C easily donates two electrons (reduction reaction) to other compounds in order to prevent its oxidation. so vitamin c is plays an important role in preventing of DNA mutation due to oxidation and maintain of protein integrity by repair of oxidized amino acid [6]. Many studies have proven that vitamin C has anti-cancer activity and increases the effectiveness of anti-cancer drugs [7].

Vitamin C contributes to enhance the immune system by maintaining of skin integrity and help to wound healing in short time to prevent enters of pathogens, where is accumulated in skin layers and act as co-factor for prolyl and lysyl hydroxylase enzymes that stabilize the tertiary structure of collagen and increase of production of collagen in fibroblast in dermal layer. Several cell culture studies have proven that the presence of vitamin C in keratocytes increases lipid synthesis and thus increases the skin's protective barrier function by different mechanisms. It was also found that giving the patient vitamin C after surgery helps reduce the time for wound healing. Ascorbic acid improves the phagocytic properties and activity of various immune
cells including neutrophils, natural killer cells, macrophages and lymphocytes.

Vitamin C increases lymphocytes proliferation and antibody production, presence of vitamin c protects neutrophils from oxidation damage, where is exposure of neutrophils to oxidants could prevent motility of these cells to infection site [8]. According to a study conducted by the University of Navarra by following 13,421 participants for 11 years, to assess the effect of vitamin C intake and its Inversely Effect Associated with Cardiovascular Mortality in a cohort of Spanish graduates, they found that vitamin C has beneficial effects on cardiovascular health .

Vitamin C may prevent oxidation of low-density lipoprotein (LDL)-cholesterol and reduce monocyte adhesion, so reducing risk of atherosclerosis. Vitamin C also prevents

vascular smooth muscle cells apoptosis, which keeps atheroma plaques stable and increases the nitric oxide production of the endothelium which contributes to reduced blood pressure [9].

Vitamin c has anti histamine effect so can be reduced duration of common cold.

Vitamin c is requiring for absorption of many vitamins including vitamin E, vitamin B15, tryptophan and folic acid. The combination of vitamin C and E enhance the efficiency of vitamin E by providing sustained release effect and regeneration of the oxidized vitamin E [10].

Vitamin C increases the absorption of heavy metals from the intestine as iron. Vitamin C has an important role in the carnitine synthesis which is an enzyme co-factor that increases the absorption of non-haem iron in GIT. It also enhances production of reduced iron which is the preferred form for the intestinal absorption [11].

Vitamin C acts as an effective depigmenting agent due to its antioxidant properties and is therefore used in the treatment of hyperpigmentation of skin [12].

Vitamin c also contributes to maintain ocular health, where combination of ascorbate with other antioxidant vitamins and minerals slow down the Progression of advanced age-related macular degeneration and loss of visual acuity in people with signs of this disease [13]. Vitamin C deficiency causes many of health problems. The most prominent sign of vitamin C deficiency is a condition known as "scurvy," with other prominent signs These include: fatigue, exhaustion, and the associated capillary system with proliferation of connective tissue weakness. Other symptoms can include: tiredness and weakness Muscle and joint pains, Dry skin, Swelling and discoloration of your gums, Poor healing of wounds and Problems fighting infections [14].

According to a study conducted on seven healthy volunteers to estimate the recommended dietary allowance (RDA)of vitamin C, they were hospitalized for a period of 4-6 months and use different doses of Vitamin C with regular screening.

The RDA (the recommended dietary allowance) is the amount of vitamin that yields the least risk of inadequacy and the least risk of toxicity. Based on data obtained from this study, 200 mg. daily is a suitable RDA for vitamin C [15].

Experts also suggest taking 200 mg of vitamin C daily for COVID-19 prevention or 1-2 grams daily for COVID-19 treatment.

Side effects of vitamin C could be only detected with large doses, this effects including diarrhea and abdominal pain, Formation of renal stones where vitamin C metabolism results in calcium oxalate salts [16].

increasing toxicity of some heavy metals such as lead and mercury because It is accelerating their absorption and Enamel erosions were detected on chewing of vitamin C tablets.

vitaminC may cause overload of iron in plasma and risk for increased oxidative stress [17].

Aim of work:

Due to the importance of vitamin c to the human's health, this research was conducted to determine of ascorbic acid content as active ingredient of vitamin c tablets and compare it to that labeled by the produced.

Experimental procedure:

The titration method was used to determine vitamin C concentration in a solution by a redox titration using iodine. As the iodine is added during the titration, the ascorbic acid is oxidized to dehydroascorbic acid, while the iodine is reduced to iodide ions.

ascorbic acid + $I_2 \rightarrow 2\ I^-$ + dehydroascorbic acid

Due to this reaction, the iodine is immediately reduced to iodide as long as there is any ascorbic acid present. Once all the ascorbic acid has been oxidized, the excess iodine is free to react with the starch indicator, forming the blue-black starch-iodine complex. This is the endpoint of the titration.

Equipment Needed:

burette and stand ,100ml beaker, Analytical balance.

100 mL or 200 mL volumetric flask,1L.V. flask

20 mL pipette

10 mL and 100 mL measuring cylinders

250 mL conical flasks.

Solutions Needed

Iodine solution: (0.005 mol/ L). Weigh 2 g of potassium iodide into a 100 mL beaker. Weigh 1.3 g of iodine and add it into the same beaker. Add a few mL of distilled water and swirl for a few minutes until iodine is dissolved. Transfer iodine solution to a 1 L

volumetric flask, making sure to rinse all traces of solution into the volumetric flask using distilled water. Make the solution up to the 1 L mark with distilled water.

Starch indicator solution: (0.5%). Weigh 0.25 g of soluble starch and add it to 50 mL of near boiling water in a 100 mL volumetric flask. Stir to dissolve and cool before using.

Sample Preparation:

Weight and dissolve a single tablet of vitamin c in 200 mL of distilled water in a volumetric flask.

Titration

1. Pipette a 20 mL aliquot of the sample solution into a 250 mL conical flask and add about 150 mL of distilled water and 1 mL of starch indicator solution.
2. Titrate the sample with 0.005 mol / L iodine solution. The endpoint of the titration is identified as the first permanent trace of a dark blue-black color due to the starch-iodine complex.
3. Repeat the titration with further aliquots of sample solution (at least three times) until you obtain concordant results (titres agreeing within 0.1 mL).

Calculations

1. Calculate the average volume of iodine solution used from your concordant titres.
2. Calculate the moles of iodine reacted.
3. Using the equation of the titration (below) determine the number of moles of ascorbic acid reacted.

$$C_6H_8O_6 + I_2 \rightarrow C_6H_6O_6 + 2HI$$

4. Calculate the concentration, in mg/100mL of ascorbic acid, in the sample solution.

$$mg/l = mol/l \times Mw$$

5. Calculate the acid weight in mg from the following equation

$$W\ mg = mg/l \times V_1$$

6.then the percentage of acid in the whole sample is calculated from the following equation:

$$\% \text{ ascorbic acid} = mg\ C_6H_8O_6 \text{ per tablet} / \text{Wt. tablet } mg \times 100$$

Results and Discussion:

The amount of an ascorbic acid for four Brands of Vitamin C Tablet is calculated from the expression**:**

$$C_6H_8O_6 + I_2 \rightarrow 2\ I^- + C_6H_6O_6 + 2H^+$$

All results of all five Brands of Vitamin C is given in Table 1.

Table 1. Result of the Percentage Content of Ascorbic acid.

SAMPLES	Label claim Mg/tablet	Concentration of ascorbic acid mg/100ml	Ascorbic acid mg/tablet	% assay result per tablet
Sample 1	**1000mg**	**457.9**	**915.8**	**92.%**
Sample 2	**1000mg**	**461.4**	**922.8**	**92.%**
Sample 3	**1000mg**	**465.0**	**930**	**93%**
Sample 4	**1000mg**	**487.9**	**975.8**	**97%**
Sample 5	**1000mg**	**620.0**	**1240**	**124%**

All the samples of tablets used were within their shelf-lives during time of study.

According to British Pharmacopoeia (B. P.), a Vitamin C tablet should contain not less than 95% and not more than 107.5% of Ascorbic acid, and from the results in Table 1, the percentage of Ascorbic acid in Samples 1, 2, 3, were under the required specification.

That is mean the patient would be consuming under-dosage of the drug, Only the Sample 4 was within the required specification. while the sample 5 was upper the required specification, that means the patient would be consuming over-dosage of the drug.

Conclusion:

The results of samples 1, 2, 3, the percentage of ascorbic acid in it was 92%, 92%, 93% respectively and they are under the required specifications. The result of sample 5 was 124% of ascorbic acid, which is above the required specifications. While the results of sample 4 were only within the required specifications, which is 98%.

From the results obtained we recommended that:

1 - from time to time Conducting an inspection tour by the authorities responsible for regulating medicines to reduce Consumption of insufficient quality or counterfeit medicines and that do not meet the requirements in order to preserve public health.

2- Pharmaceutical factories must abide by Formal standards such as B.P, United states pharmacopeia U.S.P, and European Pharmacopoeia E.P in the pharmaceutical production process.

3- Quality control personnel must be trained and qualified to play an active role in this field.

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