Government of Andhra Pradesh

Commissionerate of Collegiate Education

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PRODUCTION OF VITAMIN-C

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1. INTRODUCTION

Vitamin C is also known as L Ascorbic acid. It is a water soluble vitamin. Hence it is easily delivered to the body tissues but not well stored. Our body does not synthesize the vitamin C. So it must be taken regularly daily through food or good quality supplements. So it is an essential dietary component.

Vitamin C is important in controlling infections and healing wounds and it is powerful anti-oxidant that can neutralize harmful free radicals. In the formation of collagen, a fibrous protein vitamin C is required which supports skin, bones and muscles.

Vitamin C is necessary for the growth, development and repair of all body tissues. It is involved in absorption of Iron, in proper functioning of immune system.

Vitamin C helps in making several hormones and chemical messengers used in brain and nerves.

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2. ABSORPTION AND STORAGE

1. Vitamin C is readily absorbed from the small intestine, peritoneum and subcutaneous tissues.

2. It passes through the portal vein to the general circulation and to all tissues.

3. It is not stored in any organ and distributed throughout the body.

4. Each organ or tissue has an optimal saturation level of Vitamin C. Excess of intake it does not increases the saturation level but the excess is excreted in the Urine.

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3. SOURCES OF VITAMIN C

Usually fruits and vegetables are the best sources of Vitamin C when used in raw forms.

Richest sources: - Amla (Indian goose berry) Kakadu plum, Camu Camu.

Good sources: - Citrus fruits, tomatoes, green peppers, raw cabbage, guava, cauliflower, Strawberries.

Fair sources: - Grapes, apple, banana, kiwi, jack fruit, green leafy vegetables, salad greens, Fresh potatoes, papaya.

The vitamin C content of food may be reduced by prolonged storage and by cooking because it is water soluble and destroyed by heat.

Per a day more than 200mg of Vitamin C is served to the body through five varied servings of fruits and vegetables.

Amount of Vitamin C in mg per 100 gms of the edible portion of Fruit or vegetable.

RAW PLANT SOURCE.	**AMOUNT OF VITAMIN C IN MG/100 GMS.**
Kakadu plums	1000-5300
Camu camu	2800
Amla (Indian goose berry)	445
Guava	228
Block current	200
Yellow Capsicum	183
Red Capsicum	128
Broccoli	90
Kiwi	90
Green capsicum	80
Straw berry	60
Papaya	60
Orange/lemon	53
Cauliflower	48
Pineapple	48
Grape fruit	30
Cabbage, Spinach (Palak)	30
Mango	28
Potato	20
Tomato	14

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4. RECOMMENDED INTAKES IN MG PER DAY.

The recommended dietary allowance of Vitamin C for adults daily 90mg for men and 75mg per women.

The intake amount of vitamin C is increases in case of pregnancy and lactation periods.

Smoking can decrease the Vitamin C levels in the body, so additional 35mg of Vitamin C is suggested for smokers.

The upper level for vitamin C is 2000 mg daily taking beyond this upper level may cause gastrointestinal problems and diarrhea.

The absorption of Vitamin C decreases to less than 50% when taking amounts greater than 1000mg

Generally in healthy adults, mega dose of Vitamin C is not toxic because once the body tissues become saturated with Vitamin C, absorption decreases and any excess amount will be excreted in urine.

AGE	MALE	FEMALE	PREGNANCY	LACTATION
0-6 months	40	40		
7-12 months	50	50		
1-3 years	15	15		
4-8 years	25	25		
9-13 years	45	45		
14-18	75	65	80	115
19 + years	90	75	85	120

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5. VITAMIN C DEFICIENCY

Acute vitamin C deficiency leads to scurvy. The time line for the development of scurvy varies depending on Vitamin C body stores but signs can appear within 1 month of little or no vitamin C intake i.e. below 10 mg/day.

Symptoms of deficiency (Scurvy)

Swelling or bleeding of gums.

Hair loss

Delayed healing of skin wounds

Skin spots caused by bleeding and bruising from broken blood vessels.

Fatigue, malaise.

Iron deficiency anemia due to decreased absorption of non heme iron.

Collagen synthesis becomes impaired and connective tissue become weakened.

Today Vitamin C deficiency and scurvy are rare in developed countries. Deficiency symptoms occur only if Vitamin C intake falls below 10mg/day for many weeks and in people with limited food variety.

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6. CHEMISTRY OF VITAMIN C

Vitamin C is also called L Ascorbic acid. It M.F. $C_6 H_8 O_6$. Originally called hexuronic acid. It is a white solid, but it appears yellowish while it is in impure form. It dissolves in water to give mild acidic solutions and it is a mild reducing agent.

Ascorbic acid exists in two enantiomers L and D isomers. The L isomer is naturally occurs in many foods and is Vitamin C, an essential nutrient for humans and many animals. Deficiency of Vitamin C causes scurvy. Hence it is used as a food additive and a dietary supplement for its antioxidant properties. D form can be made through chemical synthesis but has no biological significance.

CHEMICAL PROPERTIES:

(a) Acidity: - When one of the hydroxyls is de-protonated ascorbate anion is formed.

And it resonance stabilized by electron delocalization.

Hence Ascorbic acid is more acidic it the compound contained only isolated hydroxyl groups.

(b) Salts: - The ascorbic anion forms salts such as sodium, calcium, potassium ascorbates.

(c) Esters:- It is like an alcohol reacts with organic acid forming esters such as ascorbyl Palmitate and ascorbyl stearate.

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7. PRODUCTION OF VITAMIN C
(L ASCORBIC ACID)

80% of world supply of Ascorbic acid is produced by Chaina.

The synthesis of Ascorbic acid was achieved by Reichstien in 1933, followed by industrial protection of vitamin c two years later by Roche. Today C vitamin is produced in very large industrial scale by the natural products of c vitamin. The raw material of vitamin C is corn or wheat. These are converted via starch to glucose, and then to sorbitol. From sorbitol in a series of biotechnical chemical processing and purification steps vitamin C (L Ascorbic acid) is produced.

In industry production of Vitamin C by two processes. They are explained here.

1. Reichstein Process 2. Two step fermentation process

1. REICHSTEIN PROCESS

Reichstein process is outdated, but historically important industrial synthesis of Ascorbic acid from Glucose.

In the first step of this process glucose is catalytically hydrogenated to Sorbitol. In the next step Sorbitol is oxidized by microorganism Acetobactor Suboxydans to Sorbose. Only one of the six hydroxyl groups is oxidized by this enzymatic reaction. The Sorbose is treated with Acetone in presence of acid catalyst converts the four of the remaining hydroxyl groups to Acetals. The unprotected hydroxyl group is oxidized to carboxylic acid by $KMnO_4$ as the bleaching solution. Acid catalyzed hydrolysis of formed Diaceto 2-keto L-Sorbic acid with the removal of two Acetal groups and ring closing lactonization yields L Ascorbic Acid i.e is Vitamin C with more than 90 %.

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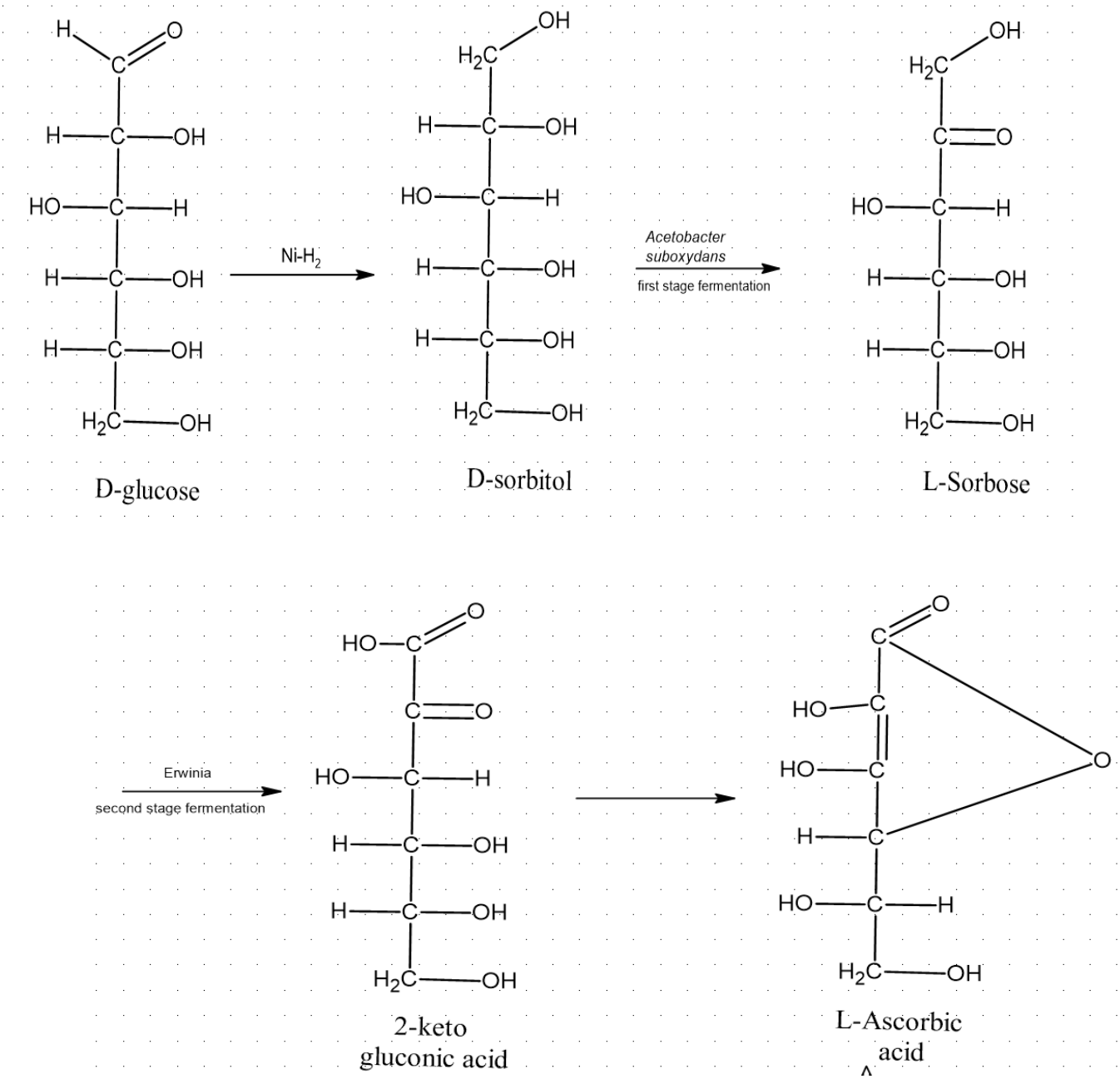
2. TWO STEP FERMENTATION PROCESS

It is developed in China in 1960, further developed in 1990. In this process a second genetically modified microle species such as mutant Erwinia oxidizes Sorbose to 2- Keto gluconic acid (2KGA) which is then undergo ring closing Lactonization via dehydration to yield L Ascorbic acid.



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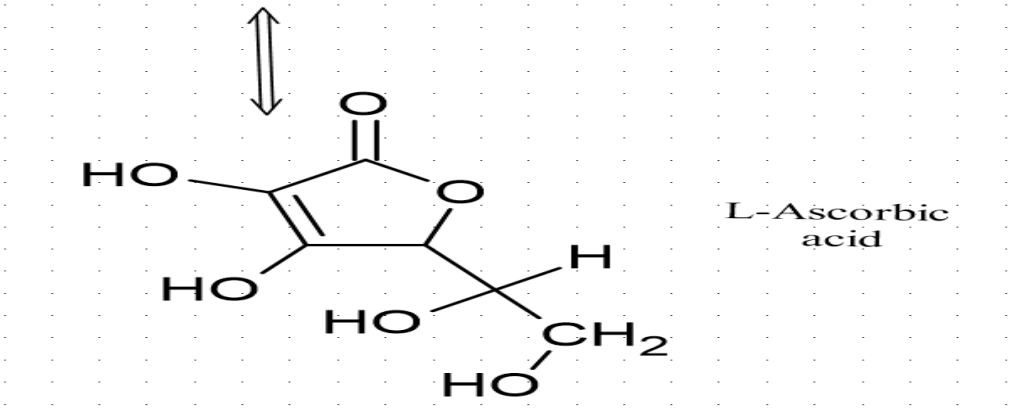
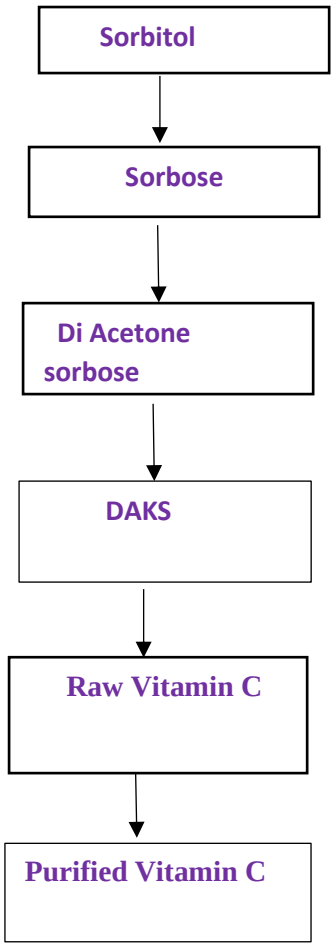
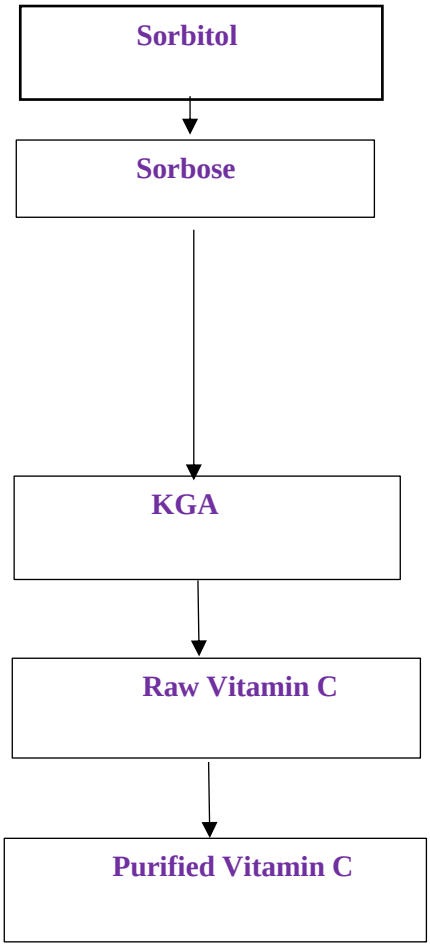


L-Ascorbic acid

Reichstein Process



Two step fermentation process



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Why Reichstein process not eco – friendly?

- Explosive gas H_2 is used
- Requires high temperature and pressure energy intensive.
- Protecting group is used.
- Acetone and $KMnO_4$ and toxic to environment.
- Low atom economy (40%).
    - Not ideal from green Chemistry point of view.

Green-based production benefited with the following the principles.

- Prevent waste
- Maximize atom economy
- Design less hazardous chemical synthesis.
- Increase energy efficiency
- Avoid chemical derivatives.
- Use catalysts, not stoichiometric reagents.
- Minimize the potential for accidents.

FERMENTATION PROCESS

- Fed batch technique

  Microorganisms K. Vulguare, S. Cerevisiare or Acetobacter suboxydans.
- Culture medium comprises of D – Sorbitol, $MgSO_4$, $7H_2O$ and $CaCO_3$.
- Carbon sources = Glucose or steep corn liquor
- Nitrogen source = Urea, Ammonia and ammonium salts.

- PH=Neutral PH which lowers to 2.5 after production.
- Temperature = 30^0 C
- Time period 24 Hours
- Proper aeration and agitation.

8. DETERMINATION OF VITAMIN C

There are many different methods are implemented in determination of amount of vitamin C in vitamin C tablets ,juices, fresh , frozen or packed fruits and vegetables.

One way to determine the amount of vitamin C in food is the process of redox titration with an oxidizing agent.

In the iodomertic method of titration Iodine is used as oxidizing agent in presence of a starch indicator. Iodine is reduced by Ascorbic acid. Then triiodide is formed with Iodine.

$$I_2 + I^- \text{ ----------} \rightarrow \quad I_3^-$$

Triiodide oxidizes vitamin C to dehydroascorbic acid. As long as vitamin C is present in the solution the triiodide ion is converted to iodide ion very quickly. When all the vitamin C is oxidized, iodide and triiodide will be present, which reacts with starch to form a blue – black complex. The blue-black color is the end point of the titration.

This titration procedure is appropriate for testing the amount of vitamin C in different samples. In this titration just iodine is used and not iodate but iodate solution is more stable and gives a more accurate result.

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9. CONCLUSION

Nowadays, health has become the most important property of human life after pandemic covid period. Diets with high content of fruits and vegetables are protective against several human diseases and even cancer. Therefore people are putting more attention on antioxidant substances such as Vitamin C .In the food industry Vitamin C is used as food additive.

Vitamin C dietary supplements are available as tablets, capsules drink mix packets in multivitamin /mineral formulations with ranges from 25mg to 1500 mg per serving. Vitamin C is also added to some fruit juices and juice drinks.

The most commonly used Vitamin C supplement compounds are Ascorboic acid, sodium ascorbate and calcium ascorbate.

Compared to plant sources animal sourced foods provide very less amount of Vitamin C.

Ex. Raw chicken liver contains 17.9 mg /100g but fried the content of Vitamin C is reduced to 2.7mg /100g

Cooking can reduce the Vitamin C content of vegetables by around 60%.

Vitamin C cannot be stored in the body so should be able to get vitamin C from your diet. Consuming five varied servings of fruits and vegetables a day can provide more than 200 mg of Vitamin C.

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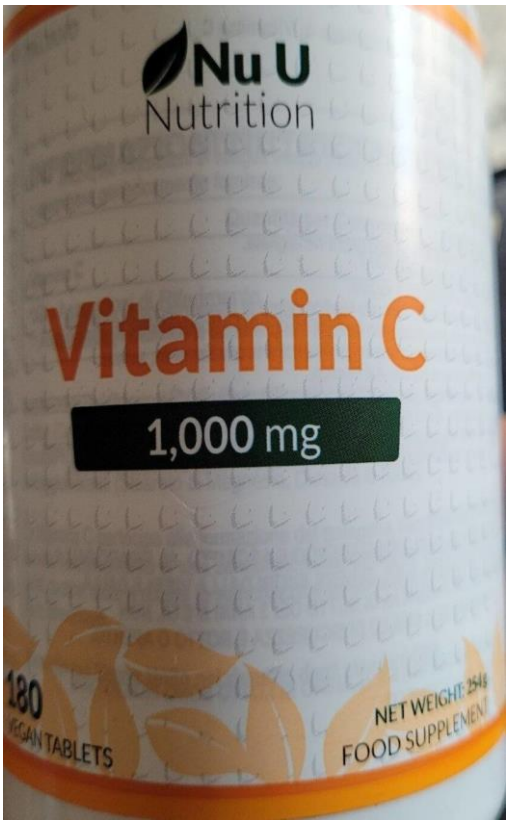
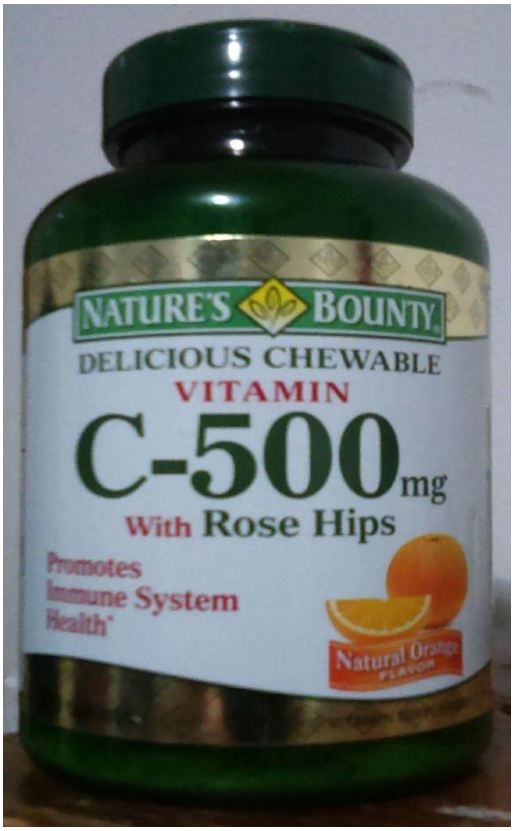
VITAMIN C SUPPLYMANTS





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