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THE VITAMIN C CONTENT OF ORANGES

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Because of the presence in the local markets of oranges marked "Color added," an advanced class in nutrition became interested in the amounts of vitamin C in different types of oranges. The chemical titration method was used for the determinations.

Vitamin C, or ascorbic acid, produces with iodine solution a definite color change that can be used to measure the amount of vitamin present. Also, with the dye, 2,6-dichlorophenolindophenol, it gives definite color changes. This method has the advantage of being much quicker than the biological method, it is less expensive, it is more sensitive to smaller differences in vitamin C content, it can be used for more different types of tests, such as measuring the changes in vitamin C content in a fruit or vegetable during ripening and it can be used to estimate the biological activity of the source of vitamin C before the biological test is made.

The disadvantages are that non-vitamin substances may give the same reactions, some of the vitamins may be non-extractable by the usual methods and yet of biological value, and the method determines only the reduced form of vitamin C while considerable of the vitamin may be in the reversibly oxidized form[3].

Oranges from Texas and California were tested, using both seed and navel oranges, those marked "Color added," small and large oranges and canned orange juice. The method of Tillman as modified by Bessey and King[1] was used. All of the fruit juices were expressed by hand on a glass reamer and were strained through four thicknesses of cheesecloth. They

were tested as quickly as possible after being expressed and hot 8 per cent acetic acid solution was added to the juice before titrating against the dye in order to eliminate sources of error.

According to Bessey and King[1], freshly expressed and strained lemon juice can be used as a standard. Guerrant, Rasmussen and Dutcher[2] found both lemon juice and grapefruit juice sufficiently reliable for standardization. In the present experiment lemon juice was tested and used as a standard every time that any juices were checked.

Using starch as an indicator, five c.c. of the lemon juice was titrated against .01 N iodine solution containing 15 grams of potassium iodine per liter until a permanent blue color resulted. Immediately after, another 5 c.c. portion of the lemon juice was titrated against the 2.6 dichlorophenolindophenol solution containing 0.10 gram of the dye per 500 c.c. until a faint permanent pink resulted. In both titrations, at least two tests were run on each juice and more were made in case the agreement was less than 2 per cent. The dye was purchased from the Eastman Kodak Company. In the dry state the dye is stable, but, as it is unstable in the aqueous state, no dye solution that was more than four days old was used for the tests. Phosphate buffer solution was also added to the dye solution to increase the stability.

The fruit juices other than lemon juice were titrated against the dye solution, using the same amount of juice and the same precautions as in the case of the lemon juice.

Each c.c. of 0.10 N iodine solution is equivalent to 0.88 mg. of vitamin C. Using lemon juice as the standard, it is possible to calculate the amount of vitamin C in the other fruit juices.

The results obtained showed no relationship between the type of orange, size or source. California and Texas oranges, navel and seed oranges, were found at both the top and the bottom of the list as given in Table I. It is interesting to find that the orange containing the highest amount of vitamin C, 0.944 mg. per c.c., was one marked "Color added" (See Table II). It should be stated that by the time the class were ready to make the test, the "Color added" oranges were practically off the market and only one lot could be obtained. This particular batch of oranges ranged from 0.620 to 0.944 mg. per c.c. of juice.

TABLE I. *Vitamin C content of different types of oranges.*

Description of fruit	Milligrams of vitamin C per c.c. of juice
California navel, medium size	0.795
Texas seed, small	0.748
Texas seed, large "Color added"	0.740
Texas seed, small	0.733
California seed, small	0.707
California seed, small	0.630
California seed, small	0.596
California navel, small	0.592
Texas seed, small	0.550
California seed, small	0.546
California navel, large	0.426
Texas seed, large	0.402
Average	0.619

The figures in Table I represent averages for the different types of oranges tested at two different periods — in the later winter and during the summer time. In Table II may be noted the range in value for the

different citrus fruit juices tested. The lemon and orange juices have a wider range and also higher vitamin C values than the lime or grapefruit juices.

TABLE II. *Range in vitamin C content in citrus fruits.*

Kind of juice	Milligrams of vitamin C per c.c. of juice
Lemon - Series I	0.635 - 0.874
Lemon - Series II	0.455 - 0.772
Lime	0.358 - 0.568
Grapefruit - Fresh	0.402 - 0.453
Grapefruit - Canned	0.374 - 0.482
Orange - Series I	0.402 - 0.944
Orange - Series II	0.546 - 0.733

From the results of this experiment, one would conclude that the amount of vitamin C in oranges varies considerably. While only one lot of "Color added" oranges was tested, in these particular oranges the process used had no effect on the vitamin C content.

Using the values found, the amount of vitamin C in one tablespoon of orange juice would range from 12.06 to 28.32 mg., for one tablespoon of lemon juice from 13.65 to 26.22 mg., for one tablespoon of grapefruit juice from 11.11 to 14.46 mg. and for one tablespoon of lime juice from 10.74 to 17.04 mg. of vitamin C.

REFERENCES

1. Bessey, Otto A., and King, C. G., 1933. The Distribution of Vitamin C in Plant and Animal Tissues and Its Determination, Journal of Biological Chemistry, 103, 687-698.
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3. Sherman, H. C., 1937. Chemistry of Food and Nutrition, Fifth Edition, MacMillan Company, New York.