Do Meat Products Contribute to the Vitamin C Supply of the Population?

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Ascorbic acid and sodium ascorbate (ascorbates) are important ingredients of many meat processing additives. Experts estimate their use in the meat curing process as one of the most essential progresses of the last years. These substances are commonly known as vitamin C. In consideration of the large quantities used by the meat processing industry it is of interest to know to which extent residual vitamin C contributes to the supply of the population.

1. The action of ascorbates in meat processing

Ascorbates are strong reducing agents. Their possible reactions with meat pigments are outlined in figure 1. These are the reduction of the trivalent iron into its bivalent form, the reduction of nitrous acid (nitrites) to nitric oxide, and the antioxidant activity.

Ascorbates are therefore additives that enable us to produce a better, more uniform and more stable meat colour. Ascorbates may decrease essentially the content in residual nitrite in the meat product. Residual ascorbates act as antioxidants in the meat products. They protect the colour pigments and the fat portion. Finally, residual ascorbates prevent the formation of carcinogenic nitrosamines in meat products (1,2,3).

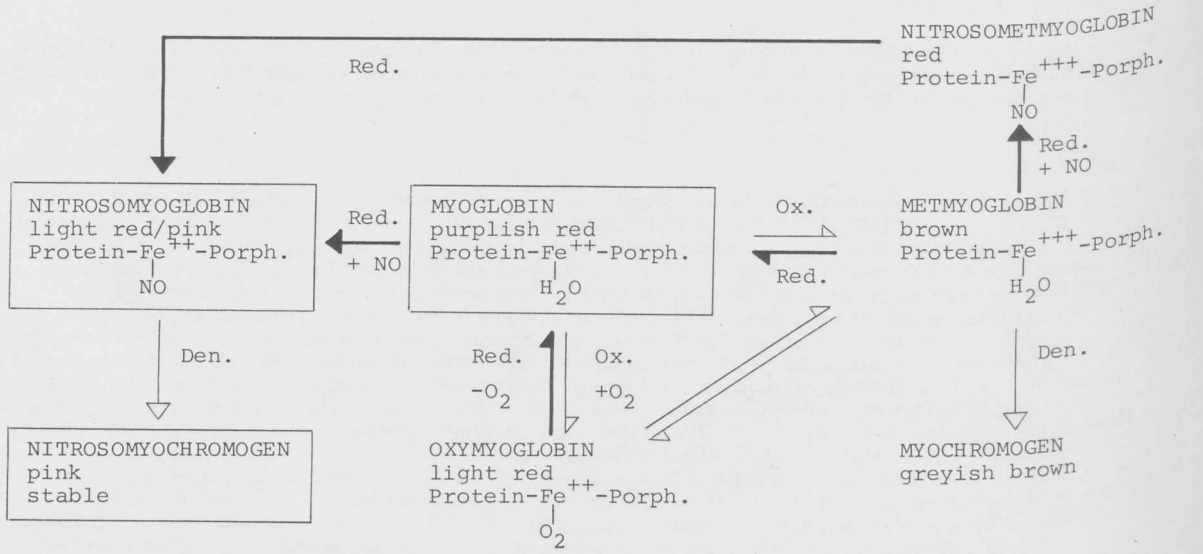
When ascorbates act as reducing agents, they are converted into their dehydro form releasing two atoms of hydrogen (Fig. 2).

Dehydro ascorbic acid is relatively unstable. Its transformation into ascorbic acid is possible under certain conditions (by enzymes, reducing agents such as cysteine etc.). In meat, in which the enzymes have been denaturated by heat, this restoring reaction does no longer take place.

Owing to trials and practical experiences it has been established that the optimum amount of ascorbates is in the range of 300-500 mg per kilogram of meat. In practical meat curing we can observe the tendency to use relatively high doses of ascorbates (1).

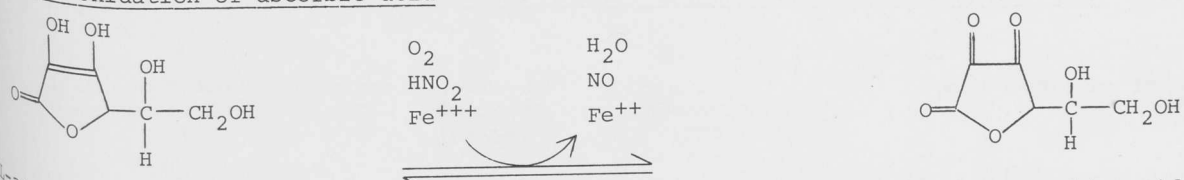
Fig. 1: Possible reactions of ascorbic acid with meat pigments

(Reactions improved by ascorbic acid are marked with broad lines)



Red. = Reduction
Ox. = Oxidation
Den. = Denaturation of proteins by heat, salt, acids etc.
Porph. = Porphyrin

Fig. 2: Oxidation of ascorbic acid



L-ascorbic acid — L-dehydro ascorbic acid

The vitamin C requirement of man

According to latest scientific works a healthy man requires an average daily intake of 100 mg vitamin C (4). This is a preliminary condition for an optimum function of many metabolic systems. Some groups - such as pregnant and lactating women, smokers, persons with a strong physical activity - have an increased requirement (5,6). Distinct deficiency diseases however may be prevented by an average daily intake of 20 mg.

Looking into the vitamin C supply of a population we have to consider that in most publications figures are based on the vitamin content of fresh foods. For practical reasons losses due to storage, preparation etc. are not taken into account. The real intake of vitamin C therefore may be 30-50 % below the theoretical content (6).

We furthermore know some groups of the population which - for several reasons - are relatively tightly supplied with vitamin C (6,7,8,10).

Quantitative determination of vitamin C supplied by meat products

The quantity of vitamin C supplied by meat products depends mainly on the meat product consumption of the population, the types of meat products, the quantity of ascorbates added and the manufacturing practices.

In table 1 some European countries are listed according to the estimated meat consumption of the population. In table 2 the same countries are listed according to the estimated theoretical vitamin C intake from meat products under the hypothesis that no losses occur during manufacturing and storage. To set an example the extent of processing and storage losses has been evaluated in Switzerland. Table 3 contains the Swiss meat product consumption and the vitamin C contents of these products. To the figures in table 3 some remarks are necessary:

- The total consumption of meat products has been split up into several groups on the basis of sales figures of some important distributors.
- The average vitamin C content has been determined by the potentiometric titration (DPI) method (9). This method does not determine the content in dehydro ascorbic acid. The real vitamin C content is therefore a little higher since the relatively unstable dehydro ascorbic acid has full vitamin C activity. Samples of all important types of meat products have been bought in several stores. The vitamin C contents vary within a large range (depending on manufacturer, packing material, age of the product etc.). The results have been ranked and an average content has been established.

Table 1

Consumption of meat products per person and year*	Countries
below 10 kg	Spain, Portugal, Italy, France
10 - 20 kg	Belgium, Norway, the Netherlands, Great Britain
over 20 kg	Denmark, Switzerland, Austria, Sweden, Germany

* meat products do not include fresh meat.

Table 2

Theoretical vitamin C intake from meat products per person and day*	Countries
below 5 mg	Portugal, Spain, France, Norway
5 - 10 mg	Italy, Great Britain
10 - 15 mg	Belgium
15 - 20 mg	the Netherlands, Denmark
20 - 25 mg	Austria, Switzerland
over 25 mg	Sweden, Germany

* based on estimated purchases of the meat processing industry and the producers of curing additives including import/export of meat products and additives.

Table 3: Meat product consumption in Switzerland / Vitamin C contents

Type of meat products	estimated consumption (tons)	average vitamin C content (mg/kg)	total quantity of vitamin C (kg)
Brühwurst: Aufschnitt etc. (several types of cold cuts)	30,000	250	7,500
Cervelat-Würste	29,000	150	4,300
Wienerli, Frankfurter Würste etc.	12,000	100	1,200
fried sausages	11,000	0	0
Kochwurst: cured types	16,000	100	1,600
non-cured types	5,000	0	0
Rohwurst	21,000	25	500
raw meat products (bacon, smoked meat products, dried meat products etc.)	35,000	25	900
cooked meat products (ham etc.)	21,000	150	3,100
Total	180,000		19,100

4. Conclusion

- In Switzerland (6,4 million inhabitants) the average vitamin C intake from meat products is approx. 8,2 mg per day and person.
- In Switzerland meat products may be rather important sources for vitamin C. Primarly some cheap and frequently consumed types of Brühwurst contain residual ascorbates. A very popular and simple evening meal consists of bread, cold cuts, ham, or cervelats, and coffee with milk.
- For some groups of the population with an insufficient vitamin C intake from vegetable foods (inadequate choice, losses during preparation) the supply from meat products may be rather important (7).
- Particularly in Germany, Austria, the Netherlands, Sweden and Denmark the average vitamin C intake from meat products is probably in the same dimension as in Switzerland.
- In various other countries meat products do not contribute much to the vitamin C supply of the population. This may be due to the relatively low consumption of meat products, for technological reasons, or legislative restrictions (e.g. for nitrite).
- In Switzerland on an average two thirds of the added ascorbates are used up during manufacture and storage of the meat products. Residual ascorbates protect the meat colour pigments from fading and the fat portion from oxidative deterioration during storage.

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