

## The use of ascorbic acid as a food additive: technical-legal issues

Michele Varvara,<sup>1</sup> Giancarlo Bozzo,<sup>1</sup>  
Giuseppe Celano,<sup>2</sup> Chiara Disanto,<sup>3</sup>  
Cosimo Nicola Pagliarone,<sup>3</sup>  
Gaetano Vitale Celano<sup>1</sup>

<sup>1</sup>Department of Veterinary Medicine,  
University of Bari, Valenzano (BA);

<sup>2</sup>Department of Soil, Plant and Food  
Science, University of Bari;

<sup>3</sup>Mediterranean and Food C.Q.S. Srl,  
Valenzano (BA), Italy

### Abstract

Ascorbic acid (C<sub>6</sub>H<sub>8</sub>O<sub>6</sub>) is an organic compound belonging to the family of monosaccharide. It is highly soluble in water, and is often called one of the secrets of the Mediterranean diet. Its use is widespread in the food industry is also important, having always been exploited for its antioxidant and stabilising ability. Many indeed are the additive formulations that take advantage of these properties. The purpose of this paper is to explain the characteristics that make ascorbic acid an important food additive and to emphasise the technical and legal issues related to its use in food productions. In particular, in the course of this employment, laws and scientific studies have been applied to the resolution of a lawsuit, having as its object the use of ascorbic acid in preparations of ground beef sold at a butcher shop. The views expressed in court by the technical consultant have led to the acquittal of the accused, in the light of the demonstrated and proven non-toxicity of the molecule and the use of a mixture of additives for the production of sausage. The European and national legislations, supported by numerous scientific studies, define the possible use of ascorbic acid according to the principle of *quantum satis*, and it can be used in foods for children. Our work aims to represent further evidence of the safety of use of ascorbic acid as a food additive, and – as confirmed by the legal decision reported – it wants to bring out the prospects for use of ascorbic acid for technological purposes even by registered establishments.

### Introduction

The ascorbic acid (C<sub>6</sub>H<sub>8</sub>O<sub>6</sub>) – better known as vitamin C – is an organic compound belonging to the family of monosaccharide. It is

strongly water-soluble and it is often considered as one of the elements that characterises the Mediterranean diet (Ferro-Luzzi *et al.*, 1994). The diffusion of its use is also most important in the food industry, which has always used its stabilised and antioxidant property. Indeed, there are several formulations of additives that contain ascorbic acid (Liao and Seib, 1988). The name, ascorbic acid, is derived from the Latin *a* (meaning *no*) + *scorbutus* and refers to scurvy, the disease caused by deficiency of vitamin C especially developed among ship's crew and known in the past. This disease was frequently identified in sailors, human beings, as well as primates, bats and some species of birds and fishes, which are not able to synthesise the vitamin C starting from the glucose. This inability derives from the lack of L-gulonolactone oxidase enzyme, responsible for the last metabolic phase necessary to the transformation of the glucose into vitamin C. Therefore, the consumption of ascorbic acid with food rich of this element, like fruits and vegetables, is essential (Ferro-Luzzi *et al.*, 1994). One of the most important characteristics of the ascorbic acid is its reducing ability. In the presence of oxygen, ascorbic acid tends to oxidise with a strong result, especially in relation to catalyst metals, removing the environmental resources of oxygen. Furthermore, the ascorbic acid can react with free radicals, arresting the chain reactions that may provoke dangerous effects on organisms, such as neoplastic pathologies of the oral cavity, alimentary system, *etc.* (Cerutti, 2006). It allows maintaining stable other important elements, such as vitamin A, E, folic acid and thiamine in organisms and foods (Mora-Gutierrez and Gurin, 2006) and it is essential for synthesis of collagen, connective tissue's protein, important to heal wounds, sores and lesions, and to the prevention of hemorrhages. In addition to prevent the onset of the atherosclerosis, vitamin C contributes to the development of the adrenaline and the endogenous serotonin and to the hydroxylation of aromatic compounds in the liver. It operates in processes of the cellular defense, facilitates the intestinal absorption of the iron and the elimination of toxic heavy metals (such as cadmium, nickel and lead) with which it is able to tie. Its action is also important in the synthesis of the carnitine in the zymotic transformation of the cholesterol in bile acid or in vitamin D.

The strong antioxidant activity of the ascorbic acid, linked to the ability to establish other elements and essential nutritional factors, encouraged industries to formulate some specific additive for the use of this substance in different food products (Cappelli and Vannucchi, 2009). The food additive could be any substance, not generally used like food itself, but added to foods to different technical

Correspondence: Gaetano Vitale Celano,  
Department of Veterinary Medicine, University of  
Bari, via per Casamassima 3, 70010 Valenzano  
(BA), Italy.  
Tel: +39.080.5478837.  
E-mail: gaetanovitale.celano@uniba.it

Key words: Ascorbic acid; Food additive;  
Technical-legal issues.

Contributions: MV and CD, writing of  
Introduction and evaluation of results; GB, bibli-  
ography search and writing of Conclusions; GC,  
writing of Conclusions; CNP, writing of Materials  
and Methods; GVC, overall idea of the project.

Received for publication: 3 June 2014.

Accepted for publication: 7 September 2015.

This work is licensed under a Creative Commons  
Attribution-NonCommercial 4.0 International  
License (CC BY-NC 4.0).

©Copyright M. Varvara *et al.*, 2016

Licensee PAGEPress, Italy

Italian Journal of Food Safety 2016; 5:4313

doi:10.4081/ijfs.2016.4313

purposes, among which their retention (Reg. EC 1333/2008; European Commission, 2008). There are several additives arisen from the ascorbic acid that nowadays we can find in trade: E300, ascorbic acid; E301, sodium ascorbate; E302, calcium ascorbate; E303, potassium ascorbate; E304, fatty acid esters of ascorbic acid (ascorbyl palmitate and ascorbyl stearate). These additives use the ascorbic acid itself (E300) or in the form of salts (E301, E302, E303) or lipophilic esters. Lipophilic esters (E304) are arisen with long fatty acid's chain to be able to use the effects of ascorbic acid even in lipidic foods, preventing the rancidification (Morrissey *et al.*, 1998).

All additives based on ascorbic acid – except for the E303 potassium ascorbate – are approved in Europe, USA, Australia and New Zealand. In these nations the use of E303 is also approved. Additives, based on ascorbic acid, are used in production and transformation phases of several foods such as beer, gelatines, jam, sweets, bread and baked products, fruit juices, wine, fishing products and meats (Bauernfield *et al.*, 1970; Liao *et al.*, 1988). The use of additives based on ascorbic acid is approved by current regulations, even in products for infants and children's feeding (Reg. EC 1129/2011; European Commission, 2011).

The use of the ascorbic acid is important, especially in production activities of the ground meat and cold cuts (Varnam and Sutherland, 1995). In meat and ground meat the ascorbic acid prevents the oxidation and the discoloration of the product during the sto-

rage (Sanchez-Escalante *et al.*, 2001; Kanner, 1994). This effect delays the appearance of an abnormal coloration that could be unpleasant to the consumer but it is not associated to the organoleptic alteration of the product (Faustman and Cassens, 1990). The use of the ascorbic acid in meats, with the addition of nitrites, is important for the activity of reduction dependent upon nitrousmetamyoglobin-Fe (III) converted into nitrousmetamyoglobin-Fe (II), which maintains the colour of the product most brilliant. Furthermore, the ascorbic acid prevents the development of nitrosamines (Izumi *et al.*, 1989).

The unauthorised use of the ascorbic acid as additive in the preparation of ground meat is often object of control by the competent authorities, with official samples. Whether the result of the laboratory analysis, made at the Institutes for Experimental Veterinary Medicine will be positive, the food business operator (FBO) will be indicted for the misdemeanor. With regard to this, the art. 5 co. 1 lett. g of L. 30.04.1962 n. 283 (Italian Republic 1962) said: *In the preparation of food and drink is banned using, selling, possessing to sell the ascorbic acid or administers it like compensation of employees or distributes it to the consumption of food substances with the addiction of not authorized chemical additives, under the decree of the Minister of Health or, whether they would be authorized, without the compliance of required rule of law for their use.*

Demonstrated the culpability of the accused for the misdemeanor of dangerous violence, conditions of the application of the art. 459 of the Italian Code of Criminal Procedure are realised with pecuniary penalty. Based on what said before, we have faced a specific case, object of legal argument in the Court of Trani (Italy).

## Materials and Methods

In the specific legal case treated here, the illegal use of the ascorbic acid has been contested to the accused, whose butcher shop is registered and authorised by the current regulations, because the law forbids the use of it in unrecognised structures, according to Reg. EC 853/04 (European Commission, 2004).

The health requisition has been provided for the product and semi-finished products because a mixture of semi-finished products based on additives and natural flavouring has been used for their preparation, only for professional consumption. But this use, according to the inspection authority, is forbidden in the preparation of meats realised in butcher shops for retail industry. The presence of the ascorbic acid in its composition, reported as last ingredient in decreasing order, emerged in the

technical file of the mixture used. The concentration of the ascorbic acid found in the official sample resulted equal to 0.07 g/kg (70 mg/kg) using the high performance liquid chromatography (HPLC) method (Iammarino and Di Taranto, 2012).

The use of additives in foods is regulated in Italy by D.M. 209/1996 (Italian Republic, 1996), which for the first time introduced the concept of the use of these substances, defining the maximum dose and limitation of employment. This national law has been the only one that regulates the use of additives in food productions in Italy since the introduction of hygienic packages and following laws. The introduction of hygienic packages introduced several laws that, today, regulate food productions in European Community. The Regulations EC 178/2002, 852/04, 853/04 (European Commission, 2002, 2004, 2004) introduced new and essential principles in activities related to the food production and new responsibilities for the FBO. Then, even the European Legislator issued laws regarding the use of food additives. The recent law, currently in force, is represented by the Reg. EC 1129/2011 (European Commission, 2011), which modified the II attachment of the Reg. EC 1333/08 (European Commission, 2008), establishing a list of food additives authorised by European Union, and then integrated by the Reg. EU 231/2012 (European Commission, 2012), which establishes specifications for several additives.

All sector law was object of search of this work and it was interpreted and applied at this specific case, regarding the protest of the illicit use of the ascorbic acid in meat preparation as the ground meat (which preserves its muscle fibrosis structure, according to the definition of *meat preparation* – Reg. 853, all. I, point 1.15; European Commission, 2004). Furthermore, the concentration found in the official sample has connected to limitations established from legislation to some product typology (especially those designed for the weakest categories at risk) and through information presented in the international scientific bibliography, to evaluate the real risk of the additive in these doses.

Limitations and definitions, presented in law deeds and also technical-legal reflections on the mixture composition, containing the ascorbic acid, were used by technical adviser as support for the defense of the accused at legal argument.

## Results

The D.M. 209/1996 (Italian Republic, 1996), already described before, indicates the modality, limitations and bans of the use of food addi-

tives.

In the All. IX of the Decree above-mentioned, there is a list of food additives that can be used in food products (except food products mentioned in the art. 15, among which there are honey, butter, milk, mineral water, coffee, foods for infants and other type of products).

In this list of additives used in food products, there are also those based on ascorbic acid, E300, E301, E302 and E304, all used according to the principle of *just enough*. This principle can be applied because these additives do not have toxic and/or negative effects on the consumer.

In the All. X of D.M. 209/1996 there is a list of food products for which only some additives, among those mentioned in the All. IX, can be used. Among food products, for which the Ministry creates limitations of used, there are the pre-packed preparations of the ground meat, in which can be only used additives such as E300, E301, E 302 and those derived from citric acid (E330, E331, E332, E333). Additives above-mentioned, in accordance of the national law, have been used with the principle of *just enough* in pre-packed preparations of the ground meat. Therefore, there is not the definition of maximum dose as testimony of a certain safety use of the ascorbic acid.

With the introduction of the community law of the hygienic package, the FBO (art. 17 of the Reg. EC 178/2002; European Commission, 2002) assumes themselves duties, regarding the production realised and/or sold by them. Indeed, in this specific case, the operator has been accused for the use of the ascorbic acid, nevertheless, he did not use a *premix* mixture authorised for the production of prepared food based on ground meat.

The Reg. EC 178/2002 to the art. 7, declares the *precautionary principle*. The FBO refers to this principle in food productions but also official controls refer to it, made by the Reg. EC 882/2004 (European Commission, 2004) in the presence of scientific error. The community law identifies the preparation of the pre-packed ground meat, as products realised only in factories recognised under the Reg. 853/04 (European Commission, 2004). In this way, the evaluation of orders and mandates introduced by the community law, in the food additives' sector, has been most important. The current regulation in European field, in the section of the additives, is represented by the Reg. EC 1129/2011 (European Commission, 2011), which modified the II Attachment of the Reg. EC 1333/08 (European Commission, 2008), making a list of food additives authorised by the European Union. E300, E301, E302 and E304 are included in the list of additives authorised, which differ from colouring and sweeten. Even in the Regulations above-mentioned, the use of these additives is authorised with the principle of *quantum satis* (*just enough*). This

principle is said even in the specific section of the Regulations for the preparation of meats with a clear reference to the possibility of use E300, E301 and E304 in the pre-packed preparation of the ground meat in a quantity that can be modified, according to the choice of the FBO, without risks for the consumer health. In support of the safe use of the ascorbic acid, there is also the possibility of use it as additive in some products for infants, as declared in the Reg. EC 1129/2011. There is a maximum fixed doses of the ascorbic acid that can be used in these foods and on the other hand, in products that differ from the productions of meat.

The community Regulations and Ministerial decree authorise the use of additives, based on ascorbic acid in the pre-packed production of the ground meat. On the basis of how said before, the interpretation of law sector is clear, because identifies the ascorbic acid as a substance that contain toxicity, absolutely negligible. Moreover, several studies testify the absence of dangerous reaction in men, related to the toxicity of the molecule that is essential for the organism's functions. In scientific literature, there are not events of toxicity or episodes of dangerous events related to the consumption of food products that contain additives with ascorbic acid.

Moreover, for the purposes of suggest proper deposition at legal argument, the technical adviser found in product's sample a low concentration of the ascorbic acid. The analysis on the official sample, made in laboratory, identify a concentration of the 70 mg/kg of the ascorbic acid in the product. This result is lower than that provided for the national and community law, about ascorbic acid contained in food productions for infants (200-300 mg/kg, according to the type of food production for infants). The thesis presented by the technical adviser, who is on the side of the accused in this legal argument, underlined the nontoxic molecule, explained by definitions, attended in the sector law and by different scientific studies against the use of limited quantity as that contained in the *premix* mixture used in this specific case.

According to what emerged from this debate and especially after concepts expressed by the technical adviser, the accused has been acquitted, with judgment n. 1182/2013 of the Court of Trani, because *the fact does not subsist*.

## Discussion

The definition of the pre-packed ground meat under the Reg. EC 853/04, requests a common recognition, for its production, under the same Regulations. But, according to an organoleptic point of view and a flow of process, the ground meat produced by registered factory is like that of *pre-packed for definition*,

coming from a factory with a common identification number, for which the use of a non-toxic additive is considered possible, even in authorised factories, both by national and common Legislators. It is important to underline that the solubility of the ascorbic acid allows an important renal excretion of an excessive levels of this substance (Cerutti, 2006).

Moreover, the ability of absorption, expressed by the organism, diminishes from the 75-95% (normal levels) to the 16% with the growth of the ascorbic acid concentration in blood and in organs (especially adrenal glands, hypophysis and *corpus luteum* in which, the molecule contains an high level of concentration).

Toxic effects of the molecule are verified especially in gastrointestinal and renal side, but they are also related to unbalance diet and not to the ingestion of food additive with the ascorbic acid. Indeed, as said before and paid attention to the judge in legal head office, in literature there are not toxic additives based on ascorbic acid in men, as testified by the principle of *quantum satis* (*just enough*), expressed by the current regulations in matter of the use of these food additives.

According to what emerged during the debate, especially to what said by the technical adviser, the accused has been acquitted because the fact does not subsist, and also because the use of the additive did not represent a risk for the consumer health. This type of sentence opens new technical-legal sceneries for the use of the ascorbic acid in food productions, and especially in the production of the ground meat and other type of meats. Indeed, the sentence above-mentioned disclosed that established by the Reg. EU 601 of the June 4<sup>th</sup> 2014 (European Commission, 2014), which clarified the transfer concept of additives in the preparation of the meat, already related in the Reg. 1333/2008. According to the Reg. EU 601/2014 above-mentioned, the European Union allows the application of the transfer principle of additives (art. 18 of the Reg. EC 1333/2008) in the preparation of meats. Therefore, allowing the presence of additives in these preparations, even if they are not authorised for this product category and not intentionally used by the producer in order that, the same additives will be, at least authorised in one of the ingredients of the same preparation of meat. Obviously, this principle is applied even in the use of the ascorbic acid in ground meats that could be ingredients used in preparations of different type of meat.

The Reg. EU 601/2014 (European Commission, 2014) represents also an important response to the need and requests of explanations about the transfer principle, shown by several producing associations and Veneto region to the Ministry of Health, culminated in the well-known newsletter prot.

18.03.2014 of the Ministry (Italian Republic, 2014). Limited index of manageability of the ascorbic acid, which legitimises the use of it only in recognised factories, has never been defined by sector laws. The application of normal hygienic customs and precise producing phases, the implementation of self control methods, based on the hazard analysis and critical control points principles, allow to equalise the producing activity of the authorised factory and that of the recognised factory, under the Reg. EC 853/04, which refers to the use of not dangerous substance, such as the ascorbic acid.

The non-toxicity of these additives, recognised by the community and national legislation and by experts of the scientific sector, associated to positive effects on their production and conservation (Okayama *et al.*, 1987; Sanchez-Escalante *et al.*, 2001), allow to use the ascorbic acid in for small and medium-sized enterprises of the food sector, which can be compared to the most important enterprises, and can respect the law and guarantee the correct information and the absolute tutelage of the consumer's health.

## Conclusions

Reasons of the sentence of the Court of Trani based on the molecule, which is not dangerous, are used to make jurisprudence, and they open new sceneries and reflections on the use of ascorbic acid in food enterprises.

## References

- Bauernfeind JC, Pinkert DM, 1970. Food processing with added ascorbic acid. *Adv Food Res* 18:219-315.
- Cappelli P, Vannucchi V, 2009. *Chimica degli alimenti*. 3rd. ed. Zanichelli, Bologna, Italy.
- Cerutti G, 2006. *Residui, additivi e contaminanti degli alimenti*. 2nd. ed. Tecniche Nuove, Milan, Italy.
- European Commission, 2002. Regulation of the European Parliament and the Council laying down the general principles and requirements of food law, establishing the European Food Safety Authority and laying down procedures in matters of food safety, 178/2002/EC. In: *Official Journal*, L 31/1, 28/01/2002.
- European Commission, 2004a. Regulation of the European Parliament and the Council laying down specific hygiene for on the hygiene of foodstuffs, 853/2004/EC. In: *Official Journal*, L 139/55, 29/04/2004.
- European Commission, 2004b. Regulation of

- the European Parliament and the Council on official controls performed to ensure the verification of compliance with feed and food law, animal health and animal welfare rules, 882/2004/EC. In: Official Journal, L 136, 25/05/2006.
- European Commission, 2008. Regulation of the European Parliament and the Council on food additives, 1333/2008/EC. In: Official Journal, L 354/16, 31/12/2008.
- European Commission, 2011. Commission Regulation, amending Annex II to Regulation (EC) n. 1333/2008 of the European Parliament and of the Council by establishing a Union list of food additives, 1129/2011/EC. In: Official Journal, L 295/1, 11/11/2011.
- European Commission, 2012. Commission Regulation (EU) n. of 09/03/2012, laying down specifications for food additives listed in Annexes II and III to Regulation (EC) n. 1333/2008 of the European Parliament and of the Council, 231/2012/EC. In: Official Journal, L 83/1, 22/03/2012.
- European Commission, 2014. Commission Regulation (EU) amending Annex II to Regulation (EC) No 1333/2008 of the European Parliament and of the Council as regards the food categories of meat and the use of certain food additives in meat preparations, 601/2014/EC. In: Official Journal, L 166/11, 05/06/2014.
- Faustman C, Cassens RG, 1990. The biochemical basis for discoloration in fresh meat: a review. *J Muscle Foods* 1:217-43.
- Ferro-Luzzi A, Cialfa E, Leclercq C, Toti E, 1994. The Mediterranean diet revisited. Focus on fruit and vegetables. *Int J Food Sci Nutr* 45:291-300.
- Iammarino M, Di Taranto A, 2012. Monitoring on the presence of ascorbic acid in not pre-packed fresh meat preparations by a validated HPLC method. *J Food Res* 1:22-31.
- Italian Republic, 1962. Hygienic discipline of production and sale of foods and beverages. In: Official Journal, L 283, 30/04/1962.
- Italian Republic, 1996. Decree of Italian Ministry of Health concerning the discipline of use of food additives allowed when preparing and preserving food, laying down Regulations n. 94/34/CE, n. 94/35/CE, n. 95/2/CE e n. 95/31/CE. In: Official Journal, L 96, 24/04/1996.
- Italian Republic, 2014. Note of the Italian Ministry of Health, prot. 18-03-2014. Available from: [www.unionalimentari.com/website/get\\_download.aspx?ctrb\\_id=2592](http://www.unionalimentari.com/website/get_download.aspx?ctrb_id=2592)
- Izumi K, Cassens RG, Greaser ML, 1989. Reaction of nitrite with ascorbic acid and its significant role in nitrite-cured food. *Meat Sci* 26:141-53.
- Kanner J, 1994. Oxidative processes in meat and meat products: quality implications. *Meat Sci* 36:169-89.
- Liao M-L, Seib PA, 1988. Chemistry of L-ascorbic acid related to foods. *Food Chem* 30:289-312.
- Mora-Gutierrez A, Gurin MH, 2006. Antioxidant compositions and methods of use thereof, US7, 118, 688 B2. United States Patent And Trademark Office, Alexandria, VA, USA.
- Morrissey PA, Sheehy PJA, Galvin K, Kerry JP, Buckley DJ, 1998. Lipid stability in meat and meat products. *Meat Sci* 49(Suppl.1): 73-86.
- Okayama T, Imai T, Yamanoue M, 1987. Effects of ascorbic acid and alpha-tocopherol on storage stability of beef steaks. *Meat Sci* 21:267-73.
- Sanchez-Escalante A, Djenane D, Torrescano G, Beltrán JA, Roncalès P, 2001. The effects of ascorbic acid, taurine, carnosine and rosemary powder on colour and lipid stability of beef patties packaged in modified atmosphere. *Meat Sci* 58:421-9.
- Varnam A, Sutherland JP, 1995. Meat and meat products: technology, chemistry and microbiology. Chapman and Hall, London, UK.