

Distribution on the sorbic acid in cooked meat produced from meat processing plants of Gyeongbuk province

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Abstract

Sorbic acid and potassium sorbate are widely used food additives with high efficiency and they are approved and recommended by FAO and WHO. Sorbic acid is one of preservatives that is mostly used in general food. Sorbic acid and potassium sorbate are used to prevent food, such as cheese, bread, beverage, and so on, from staling and molding. The world market for sorbic acid and potassium sorbate is growing and the market in Asian region is also expected to grow rapidly.

This study was carried out to measure the amount of the sorbic acid in cooked meat produced from meat processing plants in Gyeongbuk province during 2000~2003. One thousand one hundred and thirty-five samples of cooked meat(430 spices added meats, 486 grinding cooked meats, 3 bacons, 23 jerked meats, 68 sausages, 125 hams) were collected from meat processing plants and analyzed for the concentration of preservative sorbic acid by using of high performance liquid chromatography(HPLC). Sorbic acid was not detected in spices added meats, grinding cooked meats and bacons, except on jerked meats, ham and sausage. But the concentration range of sorbic acid in jerked meat was 0.00~1.5g/kg, average 0.37g/kg, and in sausage was 0.00~1.31g/kg, average 0.53g/kg, and in ham was 0.00~1.22g/kg, average 0.56g/kg. There was no sample that sorbate concentration exceeded the legal permitted level 2.0g/kg in cooked meat.

Key words : Sorbic acid, Chemical preservatives, Cooked meat

Introduction

Generally, food does not last forever, not

in the refrigerator or the freezer, nor out in the open air. Today, there are a variety of ways we preserve food. All foods contain

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bacteria. Food preservation needs to either slow down the growth of bacteria or kill it completely. Refrigeration and freezing are very common methods. Refrigeration slows the growth of bacteria and allows food to last much longer than without it. Certain types of food kept in the refrigerator can potentially last for a couple of weeks.

Freezing stops bacterial growth. Ice crystals form when water freezes. Meat and vegetables are great foods for freezing. Items in the freezer should be wrapped or covered tightly and labeled. Canning is another common method of food preservation. At home, fruits and vegetables can be boiled to kill the bacteria. Salting is another method of preserving food, and it is especially suitable for meats. The meat is soaked in a salty solution, or salt is rubbed onto the surface. Salt pulls the moisture out of the meat, which greatly reduces the growth of bacteria. Salted meat lasts an extra long time. There are also chemical substances used to preserve food longer on the shelf. Three common types of chemical preservatives are benzoates, nitrites and sulphites. The ingredients label on a food container may list a chemical such as sodium nitrite or sorbic acid. Chemical preservatives inhibit bacteria growth or kill it completely. Especially, sorbic acid ($\text{CH}_3\text{CH}=\text{CHCH}=\text{CHCOOH}$, molecular weight 112.12), called for 2,4-hexadienoic acid and 2-propenylacrylic acid, was used mold and yeast inhibitor, fungistatic agents for foods, especially meat, cheeses and milk processing products. Generally, polyunsaturated fatty acids could act strong fungistatic action, sorbic acids was easily metabolized in human body as well as the other fatty acid which is similar with the number of carbon atom existing in the natural world. Sorbic

acid, a white crystalline powder or granule form for dust free, is an unsaturated fatty acid which has two double bonds in conjugation that is, two double bonds separated only by one single bond. It and its salts (potassium sorbate, calcium sorbate; its salts are used according to differences in solubility) are used as preservatives in wide range of food products as well as in their packaging materials, since they are characterized by their broad effectiveness to inhibit molds, yeast, and many bacteria growth in food. Potassium sorbate, white to slightly yellow crystalline powder, is the potassium salt of sorbic acid and is much more soluble in water than the acid. Potassium sorbate will releases back sorbic acid if dissolved in water. It is effective up to pH 6.5 but effectiveness increases as the pH decreases. The lower pH value and amount of sorbic acid or potassium sorbate is needed for preservation. Its industrial applications include use in coating industry to improve gloss and in rubber industry¹⁻⁶.

Sorbic acid is readily metabolized. Both man and rat appear to utilize identical metabolic mechanisms for oxidation of sorbate. The long-term studies suggest that the same no-effect level applies to the salts as to the free acid. Sorbic acid and potassium sorbate corresponding to the specifications do not cause tumours when administered orally or subcutaneously. The earlier results of subcutaneously injection with an unidentified sample remain unexplained. Long-term studies on parasorbic acid which, it has been claimed, may be produced from sorbic acid, also produce no evidence of carcinogenic potential when given orally⁷.

Because of the change of life form with increasement of two-earner, simplify of die-

tary life, modern people would like to eat the foodstuffs which the cooking method is simple. There is increasing rapidly the consuming quantity in the ham, sausage and bacon of a meat processing foodstuffs. When it sees the consuming quantity in a meat processing foodstuffs between recent 20 years, there is increasing to 30 times of the consuming quantity in meat processing foodstuffs as which it was 1,896 tons in 1970, 5,779 tons in 1980 and 58,491 tons in 1990, respectively⁸⁾.

Nowadays, there is also increasing the consuming quantity of foodstuff additives used by preventing a corruption and the deterioration due to a microbe growth, and not only quantity increasement but also various styles as the development of manufacture technique in meat processing foodstuffs.

There were increasing day after day in people's concerns for the safety in foodstuff additives, that is, harmful preservatives, antibiotics, insecticides and so on.

Foodstuff hygiene's evaluation which was analysed daily acceptable intake for the foodstuff additives was practiced in the United states, Japan and other countries, It applies with the basic drafter to reduce consumer's damage thought of the necessary over against the food additive and confirm the safety for the food additive.

When sorbic acid is incorporated into food it may undergo oxidation, with the formation of peroxides and secondary oxidation products. In the presence of sufficient metabolizable carbohydrates the end-products are carbon dioxide and water. If metabolizable carbohydrates are not present, acetoacetate and acetone are also produced⁹⁾.

Yoo et al¹⁰⁾ were reported that it corre-

sponded with 0.7~6.7% of intake quantity of benzoate, *p*-hydroxybenzoate and sorbic acid in comparison of the acceptable daily intake (ADI), and butylated hydroxy toluene (antioxidant) corresponded with 9.3% in comparison of the acceptable daily intake in Korea.

Lee et al¹¹⁾ were reported that potassium sorbate was highly used up to 60% as the results of survey for the use condition in preservatives and antioxidants as indication fact in food cover materials and question paper in domestic, the preservatives next to potassium sorbate was butyl *p*-hydroxybenzoate and sodium benzoate. As the results of survey for the use condition in preservatives, sodium erythorbate was the highest(49.1%), next to sodium erythorbate was potassium sorbate(31.8%), and the use condition in antioxidants was ascorbic acid (55.4%).

In the foodstuff additives, sorbic acid and their salts act antibacterial effect to bacteria, then it effected to prolong their store duration for storage and circulation. It was used widely in the meat processing foodstuffs which begins a meat processing and others.

But the used amount was strictly limited and regulated. Permissible amount in domestic was generally under 2.0g/kg, but dressing meat, many pulverization processing and spiced meat should not be detected.

In this study, for the survey to the use condition of preservatives, that is, sorbic acid in the meat processing foodstuffs which was permitable in the law of livestock processing, we carried out to measure the amount of the sorbic acid in cooked meat produced from meat processing plants in Gyeongbuk province.

Materials and methods

Samples: One thousand and one hundred thirty-five samples of cooked meat(430 spices added meats, 486 grinding cooked meats, 3 bacons, 23 jerked meats, 68 sausages, 125 hams) were collected from meat processing plants in Gyeongbuk province.

Table 1. The kinds and number of sample collected for analysis

Name of sample	No of sample
Spices added meat	430
Grinding cooked meat	486
Bacon	3
Jerked meat	23
Sausage	68
Ham	125
Total	1,135

Investigation duration : We were analyzed the samples for the request and collecting to the Gyeongbuk veterinary service laboratory from January 2000 to December 2003.

Analytical method of sorbic acid

1) Sample pretreatment

First of all, we get 5g sample and dilute till 25ml(V/V) with distilled water, then sonicated for 30 min in ultrasonicator. Sonicated homogenizing fluid was strictly decanted 5ml, and added 0.5ml 1N hydrochloric acid and 0.005M cetyltrimethylammonium chloride (CTA) to this solution, therefore mixed thoroughly, and washed this solution with 10 ml methyl alcohol and 0.005M CTA solution in order. This washed solution was absorbed to Sep-Pak C₁₈ cartridge with the speed 2ml /min. Then, this cartridge was washed 10ml

distilled water and elutriated 10ml methyl alcohol, adjust 10ml in total volume with methyl alcohol. Finally, this solution was filtrated with 0.45µm filter, and used analytical solution.

2) Analytical method of high performance liquid chromatography

Each pretreated solution was injected 50µl to HPLC (Waters), and analyzed three times to the each sample. The concentration of all analytical results was calculated to substitute area results for the standard curve of sorbic acid. HPLC conditions for analysis of sorbic acid was shown in Table 2.

Table 2. HPLC conditions for analysis of sorbic acid

Distribution	Conditions
Mobile phase	Methanol : Acetonitrile : 5mM citric acid(pH4.0)=1:2:7
Injector	Waters UV 2487
Pump	Waters 600
Column	µ-Bondapak C ₁₈ (Waters 3.9×300mm)
Flow rate	1.0ml/min
AUFS	1
Run time	10min
Wavelength	230nm
Injection volume	50µl

3) Standard calibration of sorbic acid

Stock solution (100ppm) was prepared that 10mg sorbic acid (Sigma) dissolved 5ml 0.1N sodium hydroxide, and adjust 100ml with distilled water. Standard solution was diluted with stock solution at 2, 4, 6, 8ppm with distilled water, and each standard solution was analyzed three times for the each concentration. Standard curve was recorded

with linear regression analysis(X-coefficient value : 0.99986) with area at each concentration as shown in Fig 1.

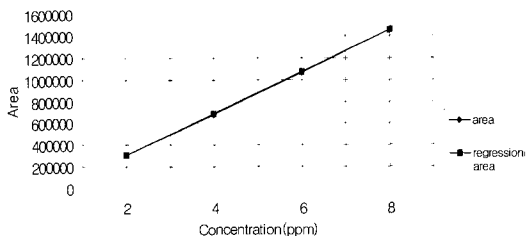


Fig 1. Standard calibration curve according to the peak area of sorbic acid according to the range 2 to 8ppm.

Results and discussion

Sorbic acid and potassium sorbate are used to prevent food, such as cheese, bread, beverage, and so on, from staling and molding. The world market for sorbic acid and potassium sorbate is growing and the market in Asian region is also expected to grow rapidly.

The value of sorbic acid, or its salts, was not immediately recognized. It would only be much later that these compounds would be appreciated for their ability to interfere with ATP metabolism in microbes, while posing no health risk when consumed by mammals. In 1939 and 1940, E Mueller(Germany) and CM Gooding(USA) discovered sorbic acid's antimicrobial properties. Subsequently, in 1945, CM Gooding and Best Foods Inc were awarded the first patent for the use of sorbic acid as a fungistatic agent in foods. Since the 1950's, sorbic acid has been repeatedly tested for safety and efficacy, and today stands as one of the most thoroughly tested food additives in history. In fact, few substances have had the kind of extensive,

rigorous, long-term testing that sorbic acid and its salts have had. It has been found to be non-toxic even when taken in large quantities, and breaks down in the body into water and carbon dioxide in the Krebs Cycle. The all-time critic of food additives, Dr Michael Jacobsen(founder of center for science in the public interest in Washington DC), has given sorbic acid and its salts his highest rating. He has indicated that, "the body metabolizes potassium sorbate like any other polyunsaturated fat." Many of the most common food additives which health-conscious americans take for granted have not received this rating: hydrolyzed vegetable proteins, common food colorings(coal tar dyes), natural liquid smoke flavorings (distillates), BHA, BHT, TBHQ, nitrates, etc^{3,4,12}.

According to the Ishiwata et al¹³, the mean concentration and daily intake of five preservatives were estimated based on the results of an analysis of 89,927 samples of food obtained in official inspections by Japanese local governments in fiscal year 1998. The mean concentration of benzoic acid was 9.5% of the allowable limit, and those of dehydroacetic acid, p-hydroxybenzoic acid, propionic acid, and sorbic acid were 1.5%, 5.7%, 1.7%, and 23.9%, respectively. Daily intake levels of these preservatives per person estimated from the concentration and daily consumption of foods were 6.23mg, 0.0303mg, 1.02mg, 8.10mg, and 25.0mg, respectively, and assuming a body weight of 50kg, the amounts of benzoic acid, p-hydroxybenzoic acid, and sorbic acid consumed were 2.5%, 0.2%, and 2.0% of their acceptable daily intakes, respectively. These values were similar to those obtained based on the results of the official inspections in fiscal years 1994 and 1996.

Table 3. The detected concentraions of sorbic acid in each cooked meat

Distributions	No of sample	Range of detected concentration	Mean (g/kg)
Spiece added meat	430	ND*	-
Grinding cooked meat	486	ND	-
Bacon	3	ND	-
Jerked meat	23	0.00-1.50	0.37
Sausage	68	0.00-1.31	0.53
Ham	125	0.00-1.22	0.56

*ND : No detectable

Sorbic acid, colorless crystal, would mildly effect mold and yeast inhibitor, fungistatic agents for foods in acidic solution as well as other antiseptics. Their acute toxicity(LD₅₀) was 7,360mg/kg in rats.

Sodium sorbate and potassium sorbate was odorless and white crystal, dissolved in water comparably, and it's use was similar with sorbic acid. In toxicity, side actions were irritation in eye and mucous membrane, sometimes occurrence contact allergy. Patients with ringworm in limbs could show erythema, soreness, and pruritus because of ointment contained sorbic acid^{13~19}.

To measure the amount of the sorbic acid in cooked meat and their products produced from meat processing plants, we were collected 1,135 samples of cooked meat(430 spices added meats, 486 grinding cooked meats, 3 bacons, 23 jerked meats, 68 sausages, 125 hams), analyzed for the concentration of preservative sorbic acid and its salts by using of high performance liquid chromatography(HPLC). As shown in table 3, sorbic acid was not detected in spice added meats, grinding cooked meats and bacons except on jerked meats, ham and sausage. The concentration range of sorbic acid in jerked meats was 0.00~1.50g/kg,

average 0.37g/kg, in sausage was 0.00~1.31g/kg, average 0.53g/kg, and in ham was 0.00~1.22g/kg, average 0.56g/kg. There was no sample that sorbate concentration exceeded the domestic legal permitted level 2.0g/kg in cooked meat. Therefore, all samples should be adjusted within permissible limits of the law of livestock processing in domestic. According to the Kim et al¹⁴, they reported the mean concentration of sorbic acid in 18 sausage was 0.35g/kg(0.00~1.46g/kg), that in 23 ham was 0.32g/kg(0.00~1.35g/kg), that in 4 bacon was 0.445g/kg(0.00~1.46g/kg). By means of Song^{15,16}, the mean concentration of sorbic acid in 14 sausage had been 0.71g/kg(0.00~1.31g/kg), that in 26 ham had been 1.10g/kg(0.64~1.46g/kg), that in 6 bacon had been 0.96g/kg(0.90~1.01g/kg).

In comparison of the results in Kim et al¹⁴ and Song^{15,16}, the mean concentration of sorbic acid in sausage and ham was similar with present study, but the mean concentrations of sorbic acid in ham and sausage was a few higher the results in Song^{15,16} than present study, and the mean concentration of sorbic acid in bacon was some different the result in Kim et al¹⁴ and Song^{15,16} than that not detected in present study. The cause of high concentration with

other reporters than present study had been thought because of many samples of preservative free products from meat processing plants in Gyeongbuk province than other reporter, and the differences of analyzed meat product.

By the survey of Kim et al¹⁴⁾, they reported that mean daily intake volume of sorbic acid in food was 6.011mg, this result was low than acceptable daily intake established by FAO/WHO, that is 0~25mg/kg (BW). In case of 50kg in human body weight, acceptable daily intake by FAO/WHO was 1250mg, this concentration was not reached the daily intake volume surveyed by Kim et al¹⁴⁾. Therefore, the use level and intake volume of sorbic acid was not considered threatening stage to human health. But we were continuously surveyed in depth because of preventing many side action to intake continuously to the specific food used by sorbic acid and its salts as preservatives and producing safe meat processing food.

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