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Effect of frozen and dried leek on processing and quality characteristics of Greek traditional sausages

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Abstract

Blanching of leek at boiling temperature for 1 min reduced ($p < 0.05$) the nitrate content. Freezing of leek at −18 °C and storage for 5 months, with or without vacuum, also reduced ($p < 0.05$) the nitrate content, while drying at 85 °C for 2 h and storage for 5 months, with or without vacuum, had no effect ($p > 0.05$) on nitrate content. Frozen leek as a whole plant was unsuitable for the production of traditional sausages. The most appropriate level of dried leek for sausage production was 20 g/kg of meat mixture. The nitrate content of sausages with frozen and dried leek ranged on the 7th day from 24.5 ± 14 to 36.3 ± 13 ppm and the nitrite content from 1.4 ± 0.4 to 2.6 ± 1 ppm. Sausages with dried leek had better ($p < 0.05$) colour, higher ($p < 0.05$) pH and lower ($p < 0.05$) TBA values. Sausages with frozen and dried leek had the same ($p > 0.05$) sensory attributes as those produced with fresh leek. Vacuum packaging affected ($p < 0.05$) the odour of fresh sausages with frozen and dried leek and the overall acceptability of fresh sausages with frozen leek. Sausages with frozen and dried leek stored under vacuum had higher scores for sensory attributes, which were not always significant.

Keywords: Traditional sausages; Leek; Freezing; Drying; Nitrates

1. Introduction

Traditional sausages are well-known and very popular meat products in Greece. In the past, on Christmas day, after pig slaughtering in a ceremonial way, people used the largest quantities of meat for sausage production. Most traditional sausages were produced by adding leek and/or onion and different seasonings. Nowadays, traditional sausages are produced throughout the year by butchers and by sausage manufacturing companies by adding nitrates and nitrites.

The use of nitrites in curing of meat products contributes to the development of a characteristic pink colour and specific texture and flavour. It moreover provides a preservative effect, against outgrowth of *Clostridium botulinum* spores as well as against other food born pathogens (Cassens, 1997a). It also is a potent antioxidant (Vosgen, 1992). Nitrates can be reduced to nitrites by the use of nitrate reducing bacteria and have the same effects in meat products (Cassens, 1997a; Wirth, 1987). According to Olesen, Meyer, and Stahnke (2004) nitrates are superior to nitrites in promoting the generation of important branched-chain flavour compounds in fermented sausages.

Dietary nitrites have been associated with methemoglobinemia. Fatal toxic methemoglobinemia due to high levels of nitrites in drinking water or occupational exposure to nitrites has been reported (Ger, Kao, Shih, & Deng, 1996). Also, nitrites may react with certain amines in foods and produce carcinogenic *N*-nitroso compound nitrosamines (Atanasova-Goranova, Dimova, & Pevicharova, 1997; Mirvish et al., 2000; Van Maanen, Pachen, Dallinga, & Kleinjans, 1998). This has led to restrictions of nitrate and nitrite levels in food and drinking water. Studies related to the metabolism and digestion of nitrates in mammals showed that nitrates are converted to nitrites in the oral cavity that then "fuels" an important resistance mechanism

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against infectious diseases in mammalian species. Moreover, there is now evidence that the conversion of nitrates into oxides of nitrogen prevents the formation of carcinogenic nitrosamines (Duncan et al., 1997; Huang, Ji, & Hou, 1996). Recent studies demonstrate that nitrites, upon their ingestion and mixture with gastric acid are a potent bacteriostatic and/or bactericidal agent and that ingested nitrates are responsible for much of the ingested nitrites. Acidified nitrites have been shown to be bactericidal for oral, gastrointestinal, and skin pathogenic bacteria (Archer, 2002). Nevertheless, there is a hypothesis that consumption of dietary nitrites may be related to the subsequent risk of cancer in children and possibly in adults (Vosgen, 1992). Since the rate of formation of nitrosamines is proportional to the square of the nitrite concentration, reduction of the latter has an enlarged effect in reducing the amount of nitrosamine formed (Lijinsky, 1999).

Vegetables, drinking water and meat products are the major sources of nitrates in human diet. Especially vegetables which provide more than 85% of the average daily human dietary intake (Cassens, 1997b). Nitrate levels in vegetables are known to vary considerably according to growing conditions: biological fertilization, soilless cultures, harvesting season and light and temperature, conditions (Amr & Hadidi, 2001). Levels also vary within the parts of the vegetable and with the storage conditions (Huarte-Mendicoa, Astiasaran, & Bello, 1997).

Leek *(Allium porrum)* is a source of nitrates as well as a rich source of sulphur volatiles like thiopropanal *S*-oxide, thiosulphinates and related compounds (zwiebelanes, capaenes) in minor quantities, which participate in the rich flavour (Ferary & Auger, 1996; Mondy, Duplat, Christides, Arnault, & Auger, 2002). On the other hand some secondary metabolites are endowed with interesting biological activities. Flavonol glycosides have inhibitory activity on human platelet aggregation and prevent atherosclerosis and they also have an antioxidant activity (Fattorusso, Lanzotti, Taglialatela-Scafati, & Cicala, 2001). Allium plants also possess antifugal activity due to the chitinaces (Vergawen, Van Leuven, & Van Laere, 1998; Yin & Tsao, 1999) and they have high contents of inulin-type fructans with good effects on serum lipids, blood glucose and the gastro-intestinal environment of humans (Causey, Feirtag, Gallaher, Tungland, & Slavin, 2000).

Leek is added in Greek traditional sausages in most areas of Greece. Fista, Bloukas, and Siomos (2004) have studied the effect of leek on processing and quality characteristics of Greek traditional sausages. They found that traditional sausages produced with 240 g of leek/kg had higher ($p < 0.05$) scores for odour and taste as well as for overall acceptability compared to control sausages with 100 ppm sodium nitrite. Their quality characteristics can be further improved by adding starter culture and ascorbic acid.

However, the leek is a seasonal vegetable, which is available from October to May. Therefore, fresh leek cannot be used for the production of traditional sausages from June to September. In order to produce traditional sausages with leek outside its harvesting period, two methods for conservation of leek can be used: freezing or drying. Freezing has the advantage that the changes to nutritional or sensory qualities of the food are very small when correct freezing and storage procedures are followed, but it requires more energy consumption for freezing and preserving the frozen product. On the other hand, drying has the advantage that the dried product can be preserved under ambient conditions and requires very little storage space, but the nutritional and sensory attributes of the product may be changed (Fellows, 2000). Although freezing and drying are two effective methods of preserving vegetables generally, we did not find any published studies in the available literature, related to the suitability of frozen and dried leek for the production of traditional sausages.

The objective of this study was to investigate: (a) the effect of blanching, freezing and drying on the nitrate content as well as on the colour of leek, and (b) the effect of frozen and dried leek on processing and quality characteristics of Greek traditional sausages.

2. Materials and methods

2.1. Experimental design

Two experiments were carried out as follows.

2.1.1. Experiment 1

Fresh leek was obtained from a local super market at the end of May. After removing the inedible parts, the leek was cut in small pieces. The pieces were mixed by hand and divided into two parts. One was used as the control and the other for blanching. The blanching was done in boiling water for 1 min. The nitrate content was determined and the colour was measured in each sample (Table 1).

Unblanched leek was divided into two parts. One was packed in plastic pouches with or without vacuum and frozen at −18 °C for 5 months. The other was dried at 85 °C for 2 h, packed in plastic pouches with or without vacuum and stored for 5 months under ambient conditions. The nitrate content was determined and the colour was measured in each sample on 0 day for dried leek and after 5 months of storage for frozen and dried leek (Table 1).

2.1.2. Experiment 2

2.1.2.1. Preliminary experiments. Preliminary experiments were carried out in one replication in order to study the effect of (a) the degree of cutting of the frozen leek and (b) the level of dried leek on the processing and quality characteristics of sausages to determine the optimum procedure or level. Three treatments of Greek traditional sausages were prepared with unblanched frozen leek stored for three months at −18 °C, (a) as whole plant and (b) cut in small pieces. Six treatments of Greek traditional sausages were prepared with unblanched dried leek, stored for three months, with 0, 10, 15, 20, 25 and 50 g/kg of meat mixture.