Co-extrusion technology for comminuted meat products: alginate as a "casing" of casingless meat products

Josef Kameník

Department of Meat Hygiene and Technology
Faculty of Veterinary Hygiene and Ecology
University of Veterinary and Pharmaceutical Sciences Brno
Brno, Czech Republic

Abstract

The co-extrusion process is a good alternative to the standard production of small-diameter comminuted meat products whose batter is filled into casings. The principle of the co-extrusion process takes advantage of the ability of sodium alginate to develop strong and elastic gels on exposure to calcium ions. This method can be used in the preparation of products of various types – frankfurters, grilling sausages and dry fermented sausages (smoked or with surface mould). Higher productivity and lower production costs in comparison with traditional processes are the main advantages promoted by suppliers of this technology.

Alginic acid, calcium ions, gel, production costs

Introduction

Man is always seeking new possibilities and new ways and means of doing things. Comminuted meat products have been stuffed in natural casings for centuries. At the beginning of the twentieth century, however, the boom in meat production and the First World War combined to cause a shortage of these casings. The development and later the application of new types of artificial casings based on cellulose, collagen and textiles began. All these types of casing are now familiar to us. Then someone had the idea, "how about a sausage with no casing at all? Is it even possible?" We know that it is, now. Co-extrusion technology today is based on the ability of alginate to create thin, elastic and strong thermo-stable gels under certain conditions. Its commercial use dates back to the 1950s when fatty sea fish (mackerel and herring) in Norway were protected against oxidative rancidity by means of surface treatment with alginate, which formed a gel by means of the action of calcium ions (Gennadios et al. 1997).

Alginates – sources, structure and properties

Alginates are obtained from the cell walls of brown seaweed, from which they are extracted in the form of alginic acid (Lamkey 2009). Alginic acid is a co-polymer of two uronic acids, i.e. β-D-mannuronic and α-L-guluronic acids (Rhim 2004). Alginic acid has a unique gelling ability – it forms gels in the presence of divalent cations. The preparation of alginates includes neutralisation during which uronic acids are converted into their salt forms – mannuronate (M) and guluronate (G). In their natural state, M and G units are linked together in one of three blocks – MM, GG or MG (GM). The mutual proportions and lengths of these groupings (blocks) determine the chemical and physical properties of the molecules. Alginates with high levels of the GG fraction form strong gels. These groupings are present in the stalks of seaweed, while alginic acid in the form of M fractions is found in leaves (Lamkey 2009). Sodium alginate (E401) is used most frequently in the food industry, while potassium alginate (E402), ammonium alginate (E403), calcium alginate (E404) and propylene glycol alginate (E405) have also found applications (Thelen 2014).

The application of alginates in co-extrusion technology

Alginates are soluble in cold water and do not require heating to form a gel. Gels are produced in the presence of polyvalent cations, usually calcium cations (Lamkey 2009).

Address for correspondence:
MVDr. Josef Kameník, CSc., MBA
Department of Meat Hygiene and Technology
Faculty of Veterinary Hygiene and Ecology
University of Veterinary and Pharmaceutical Sciences Brno
Palackého tř. 1/3, 612 42 Brno, Czech Republic

Phone: +420 541 562 008
E-mail: kamenikj@vfu.cz
www.maso-international.cz

Calcium ions are more effective than magnesium, manganese, aluminium, ferrous or ferric cations (Gennadios et al. 1997). Alginates are traditionally used as thickeners or gelling agents in the food industry. Sodium alginate has found a use in co-extrusion applications as a casing for meat products (Thelen 2014). It has a paste-like consistency and its viscous properties make it suitable for extrusion. When used in this way, alginate is exposed to the action of calcium chloride. A chemical reaction occurs immediately, during which calcium ions bind to alginate GG-blocks, thereby forming a three-dimensional network (Fig. 1). This is known as an "egg-box" structure as the calcium is surrounded by GG-blocks like an egg in an egg box (Thelen 2014). This happens within a few milliseconds. Sodium alginate is turned into calcium alginate which is highly viscous and creates a surface film that forms the product casing. This reaction may, however, be reversible, i.e. the opposite reaction takes place under certain conditions. This is, of course, undesirable. Depending on the composition of the batter, which is co-extruded along with the alginate, measures can be taken to stabilise the alginate film. These include, for example, the use of calcium lactate or calcium sorbate in the batter. This is necessary if the batter contains a high content of table salt (> 2%) or if phosphates are used.

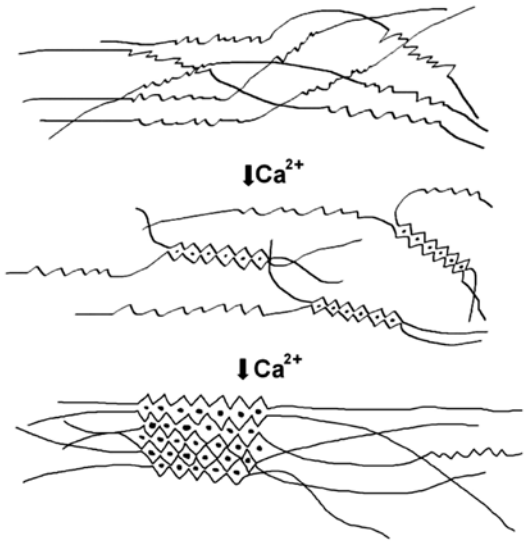

Fig. 1. The effect of calcium ions on the structure of alginate – the "egg-box" structure (Thelen 2014; printed with the permission of Fleischwirtschaft)

Why consider the use of co-extrusion in the first place? Firstly, it provides cost savings when compared with traditional casings (as much as 40% in comparison with the use of natural casings). According to German technologists, the costs for this type of "casing" are between 0.07 and 0.20 EUR per 1 kg of a final product depending on the manufacturer and the proportion of alginate (generally between 3 and 6%). In addition to this, co-extrusion is a continuous process – it means an end to the delay caused by changeover and fitting casings to the stuffing tube. It offers an extremely wide range of possible uses, from production of cocktail sausages of 8 mm in diameter to sausages of 32 mm in diameter. It can be used for dry meat products (smoked or

covered with mould), traditional frankfurters or fresh products designed for grilling or other methods of cooking (Plate XI, Fig. 2, Plate XII, Fig. 4 and 5).

The German manufacturer of vacuum fillers Handtmann offers the ConPro system (Continuous-Production-System), which has been on the market since 2004, for co-extrusion (Plate XI, Fig. 3). The ConPro System 400 is suitable for industrial production, the ConPro System 200 for medium-sized companies.

Vemag Maschinenbau GmbH, another leading player on the market is not lagging behind. Its co-extrusion equipment Coex Casing CC215 can be integrated into a filling line. The device permits an output of around 1 000 portions a minute at a product length of 120 mm.

The co-extrusion technology uses two coupled fillers – one delivering specified amounts of batter, the other specific amounts of the alginate. Alginate is applied to the batter in the co-extrusion head. The product is subsequently treated with calcium chloride. An elastic surface film that can completely replace natural or artificial casings is formed by a chemical reaction. Modern equipment can wind and hang frankfurters and cocktail sausages with practically no need for human intervention. The products are delicate to the bite, and the producer can request alginate enriched with liquid smoke, colourings or aromatics from the supplier. It is clear that the development of co-extrusion technology cannot be halted in the field of meat processing.

References

Gennadios A, Hanna MA, Kurth LB 1997: Application of edible coatings on meats, poultry and seafoods: A review. LWT - Food Sci Tech **30**: 337-350

Lamkey JW 2009: Nonstarch hydrocolloids. In: Tarté R: Ingredients in Meat Products. Properties, Functionality and Applications. Springer Science + Business Media, LLC, New York. 419 p

Rhim JW 2004: Physical and mechanical properties of water resistant sodium alginate films. LWT - Food Sci Tech **37**: 323-330

Thelen C 2014: Co-Extrusion macht Würstchenfüllen effektiver. Fleischwirtschaft **94**: 48-51 (In German)

Fig. 2. Products of the "Bratwurst" type made with the use of co-extrusion technology (Handtmann)

Fig. 3. The ConPro system for the co-extrusion technology (Handtmann)

Fig. 4. Salami sticks made by co-extrusion technology (Handtmann)

Fig. 5. Frankfurters made with the use of co-extrusion technology are indistinguishable from products made with the traditional use of casings – detail of hanging on Handtmann machinery (Kameník J)