Hand-in-hand with the rise in world population, the increase in relative global affluence and the finiteness of available resources, the human race is on the search for alternative and additional sources of food. A modified way of covering daily protein needs from animal sources plays an important role here. While affluent societies are sometimes characterized by mainly high meat consumption, in western industrialized nations an opposite trend is currently being observed: vegetarianism, veganism, flexitarianism and their intermediate forms are on trend here.

By Michael Weinberger

According to a study by the Federal Ministry of Food, 90% of Germans believe it is important to consume a balanced and healthy diet. According to a Forsa survey, the greater part of the population state that they eat meat daily or at least several times a week. However, an ever increasing number of people want to reduce their meat consumption. The reasons for this are diverse – whether health aspects, ethical/moral aspects, or for environmental reasons. It is therefore not surprising that alongside small producers, major food manufacturing groups have now become interested in the market potential of alternative protein sources, are developing new products and reviewing a market launch. In view of the shrinking meat market, even established meat product firms have now started to expand their product portfolio to include vegetarian and vegan meat substitute products and meat analogues. Furthermore, growing numbers of spin-offs from meat processing enterprises are also emerging and specializing in the production of products from alternative protein sources.

Texturizing proteins

Cooking extrusion provides a suitable technology for converting protein sources into attractive foods. Such an extruder combines various process stages in just one machine. Raw materials can continuously be mixed, kneaded and cooked under thermal and mechanical energy input. They are then moulded into the desired end product form. The desired textures can be achieved via the four main parameters of water content, specific mechanical energy introduction, specific thermal energy introduction and dwelling period. The process is characterized above all by its versatility, the comparatively low investment, the low maintenance costs and the constant product quality.

Fundamentally, all kinds of proteins can be texturized as long as they are available in sufficiently concentrated form. Ideally the protein-containing raw material used should display low fat and low fibre contents. The palette of possible raw materials extends from animal sources such as casein, via vegetable proteins such as wheat gluten or pulse proteins and lupins to proteins from fungi or insects such as the mealworm. While the latter group is already a fixed component on the menu in Asian countries, and will only appear here in the distant future, pulses are now increasingly making their way into the spotlight. This is due not least to the fact that the UN has proclaimed the year 2016 as the "International Year of Pulses".

In order to transform a protein source into a meat analogue, the raw material with its protein content is pressed through a nozzle together with water under high energy with the introduction of shear energy and moulded at the same time. Protein concentrates and isolates with protein contents of over 60% are most suitable for this. Further ingredients such as

**Texturates**

Vegetable-proteins serve as meat substitute

Trend to vegetarianism leads to wet texturates becoming established as mainstream product

The Poly-Twin BCTG-62 produces dry and wet texturates.

Photos: Bühler AG
salt or colorants and aromas can be dosed directly together with the main components. Through a suitable selection of the process parameters in the extruder, the proteins are cross-linked and fibrillar structures are formed, making it possible to imitate muscle fibres. In the industry jargon, this process is called texturizing and the end products are called texturates. A distinction is made between dry texturates and wet texturates.

In addition to the above extrusion parameters, the pH value can also influence the degree of texturizing of the proteins. Shifting the pH value into an alkaline milieu leads to improved protein solubility, while pH values in the acid range cause the opposite effect and it is more difficult to process the proteins. Slight additives from substances containing sulphur such as, for example, cysteine, have a positive effect on the interlinking properties of proteins. In this way disulfide bridges can be split and the structure of the protein molecules can be rearranged so that they can be texturized better.

Dry texturates remain on the market

Dry texturates have already been established on the market for a relatively long time. They are mainly offered in the trade in granular form as minced meat substitute or cut into chunks or strips and are also increasingly being used as a filler material in the production of industrially processed foods. On the grounds of their sponge-like porous structure, they all demonstrate a high liquid absorption capacity of up to 400% of the dry volume. They have to be placed in water for ten to fifteen minutes prior to preparation, or they can be cooked with other ingredients in the cooking liquid. They display a relatively elastic, short-fibre consistency. Soy has become established as a raw material here, but products on a pea and lupin basis are also obtainable.

Dry texturates are produced by means of an extrusion process. For this the protein is extruded with water contents of below 30%. In view of the high temperatures of over 160 °C and pressures of around 100 bar in the extruder, the dough expands on emerging from the nozzle. This is because the evaporating water escapes from the product as the pressure drops and practically inflates the product. Depending on the selection of the process parameters and the geometrical dimensions of the extruder nozzle, different end product shapes and pore structures can be achieved. The extrudates are then dried to a target moisture content of below 5%. Optionally they can be ground and screened to the desired particle size distribution before packaging.
Wet texturates are on trend

At present a trend above all towards wet texturates can be observed. By contrast with dry texturates, they do not need to be rehydrated. They are very similar to muscle meat in their structure and texture. The analogues are offered in a large number of forms – from gyros to schnitzel – and generally appear on the market already marinated or breaded. In recent years great progress has been made as regards the quality, so that these products have successfully moved on from the organic market/health food shop niche to the shelves of major food retailers, picking up a broad group of customers on the way. On the one hand the producers have been able to improve their products above all as regards quality, taste, shape and appearance, while on the other hand the sustained vegetarian/vegan hype has contributed to establishing them in the mainstream. In the meatless protein business, it is extremely important to communicate emotions and lifestyle. Accordingly it is not surprising that an estimated 80% of consumers are actually meat eaters by preference. Increasing consumer acceptance can be expected, even though it will probably take some time before the products shrug off their lifestyle image and gain a firm place on the shopping list alongside butter and flour. The product currently found most frequently in the wet texturate segment is chicken breast analogue. Other meat textures are still at the development stage. Nearly all producers work with soy as a protein source, but pea protein also plays a major role. Other protein sources such as lupins or lentils are the subject of current research work. Now that the form, taste and mouthfeel are similar to those of conventional meat, the developers are focusing on nutritional physiological issues. Topics such as the bioavailability of the nutrients and a balanced amino acid profile, which reportedly approaches that of meat, are particularly relevant here. Combinations from different vegetable protein sources compensate one-sided amino acid profiles and aim to ensure a balanced meatless diet. Alongside health aspects, this is vital in order to achieve even broader acceptance and a wider market.

The wet texturate production process also uses extrusion technology, but the process is only similar to that of dry texturates to a limited extent. First of all the protein or a protein mixture is dosed into the extruder. This is where micro-ingredients such as salts, aromas or colorants and vitamins are usually added. In addition to the process water, oils or other liquid components can be added. Due to the high water content of around 60% and the shear energy to be introduced into the extruder, a substantially longer process step is necessary. On average the proteins need process temperatures of 140–170 °C in order to form fibre structures. However, as it is not desirable for the dough of wet texturates to expand, it must be cooled at the exit from the extruder. This is done with the help of a special cooling nozzle which assumes the function of a heat exchanger. In this stage cold water permanently flows around the dough and cools it to below 100 °C over the process length. Depending on the settings of the process parameters, different textures can be generated. These range from short-fibre, more elastic structures to long, partly cross-linked fibres. Foa-
Vegetable proteins serve as meat substitute

My porous textures are also possible. After the texturates have left the cooling nozzle, they are cut to the desired form with the help of cutting equipment. If the micro-ingredients have been added already at the start of the extrusion process, the texturates can now be packaged directly and subjected to a deep-freezing process. Furthermore, it is also possible to rub flavour and aroma substances into the texturates in a kind of marinade before they are packaged and deep-frozen. As wet texturates have a water content comparable with that of fresh meat, they have to be subjected to a cooling chain just like the meat. Without doubt, animal protein will continue to appear on the table, but vegetable protein sources will play a greater role in future and also substitute a part of the meat consumption in Europe. Initial indications of this are already apparent and a steady increase is to be expected in the future. From a global aspect, inclusion of alternative protein sources in diets will be indispensable, given the current demographic population development.

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