In a bowl cutter, the complete production process of minced meat-like meat substitutes, such as burger patties, can be operated in one machine.

Hype, trend or the future market?

Meat substitutes made from vegetable proteins have arrived in everyday life

According to forecasts, the market for plant proteins is expected to grow continuously and strongly (Investment Bank Barclays, 2019). The market for meat replacement products is very dynamic and therefore reacts very quickly to the criticism it receives. For example, the fats used – keywords being saturated and unsaturated fatty acids – and the calorie content of the products are being fine-tuned. The functional additives used are also increasingly being put to the test and replaced by less critically regarded ones.

By Andreas Seydelmann und Stefan Geisen

One may ask oneself, where suddenly all the vegans and vegetarians come from. In fact, these diets are becoming increasingly popular and it can be assumed that about one billion people now eat exclusively meat-free – the majority of them for cultural or religious reasons. Strictly speaking, however, this population group does not even represent the consumers that meat replacement products are aimed at, because they usually do not attach importance to the fact that something looks like meat.

The target group

The target group primarily consists of the "flexitarians", who, according to current surveys, make up about 20% of the world's population (Euromonitor, 2019) – with a strong upward trend. This relatively new word creation is used to describe people who consciously want to do without meat from time to time – but without giving it up completely. For them it is often important that the meatless products are nevertheless as close as possible to meat. A meatless burger should taste and look like a burger, meatless sausage like sausage and meatless nuggets like nuggets – and it should also feel authentic in the mouth. The reasons for doing without are very different: they range from animal welfare to environmental and health consciousness.

Another reinforcing factor of this trend is certainly the increasing desire to try new things and the growing demand for convenience food, i.e. ready-made food that can be prepared with little effort.

The reasons for this are changing living conditions and the desire to eat healthy food without spending a lot of time (The Nielsen Company (US), LLC, 2018).

What's in it?

The ingredients of meat replacement products based on vegetable proteins can be divided into four groups – protein, water/ice, oil/fat and spices/additives for taste, binding, shelf life and color. The challenges in production, apart from the right recipe to define the taste, also lie in the selection of the right raw materials to achieve the desired texture and mouthfeel.

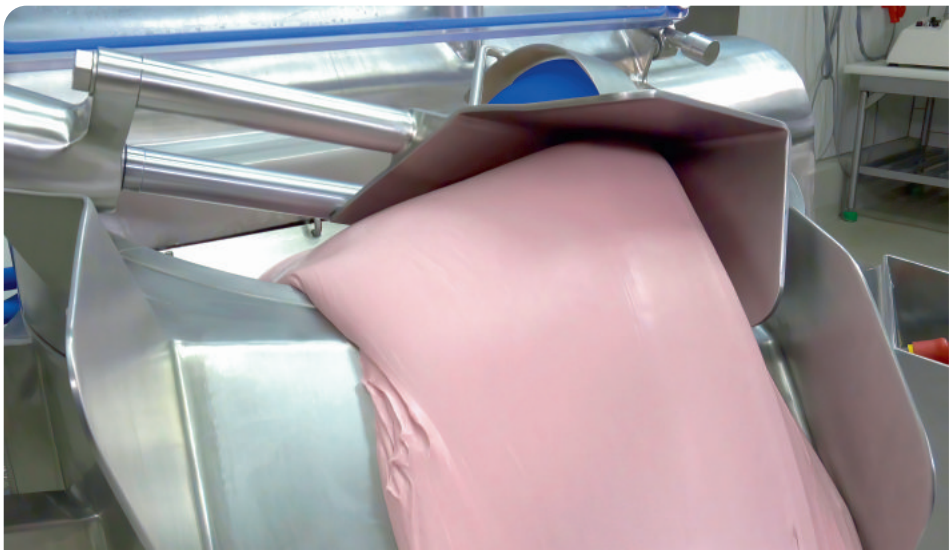
The range of protein suppliers extends from soybeans and peas to potatoes, wheat or mushrooms. New sources of proteins are constantly coming onto the market. This is also experiencing strong growth and is moving very fast. There are essentially two categories, which are based on the desired texture of the end product, as well

as the production method. Textured raw materials (TVP, Textured Vegetable Protein), obtained for example by extrusion and characterized by an existing fiber structure, and starting material in powder form (the so-called hydrolysates obtained by hydrolysis) can achieve a particularly high protein content of 80% – and are usually available in powder form. The textured vegetable protein is an industrially produced meat substitute made, for example, from defatted soybean flour, a by-product of soybean oil production. But peas or cereals are also used as a source of raw materials.

The thermoplastic protein is extruded under high pressure at 150–200 °C, where it is transformed into a fibrous and porous mass. The drop in pressure as it exits the extruder causes the material to expand – a very airy product is created, which is then dried. By absorbing water, the practitioner speaks of hydrolysis, the TVP produces an elastic fibrous structure, sensorially comparable to meat fibers of animal origin and thus the most important basis for analog burgers, analog schnitzel and similar products.

Depending on the target product, different vegetable oils or fats are used. In the production of minced meat substitutes or burger patties, for example, a proportionate use of coconut fat is very common. This has the advantage of forming the white fat portions expected by the consumer at room temperature and especially in the refrigerator, melting during frying and thus producing a juicy bite typical of patties.

The products get their color from different substances. For example, in addition to beetroot and other colorants, a hemoprotein mixture, a type of meat juice produced by fermentation, is also used. In almost all products currently on the market, methyl cellulose is used as a thickening and binding agent. This additive, also known as E 461, has the ability of binding a lot of water when cold and gelling when heated. This gel formation results in a juicy mouthfeel of the products. Known to many as the basis of wallpaper paste, methyl cellulose has long been used as a thickener and emulsifier in the food industry as a gelling, thickening or stabilizing agent in products such as ketchup or sauces. The mode of action in the human body is similar to that of dietary fibers. The white powder is produced from cotton by a chemical process. Just like these, it is not digestible, non-allergenic and non-toxic for humans. Therefore, it is considered harmless to health and may be used in foods according to the principle of "*quantum satis*".



The batter of emulsion-based vegan hydrolysate products is often very firm and sticky.

The spices used are essentially no different from those also used in meat production – with one very decisive exception. The reason for this one difference lies in a fifth taste, which is different from salty, sweet, sour and bitter. It is described as hearty-intensive, spicy or meaty and is named with the word "umami", which comes from the Japanese. The trigger for this taste sensation is a protein building block colloquially known as glutamate. This occurs in its natural form in all living organisms. Animals, plants and humans form it themselves. But it has fallen into disrepute in the form of the artificially produced monosodium glutamate. Yeast extract or fried mushrooms are usually used as a source of glutamate in meat replacement products. Nori, a type of algae, or dried tomatoes are also conceivable – both have a high natural glutamate content. Glutamate is the salts of glutamic acid, which are called with this collective term and this acid is an amino acid, basic building block for proteins. Body glutamate is called endogenous glutamate. Those that are taken in with food as a taste enhancer, as exogenous glutamate. Many manufacturers also use yeast extract instead of the controversial monosodium glutamate. This is popularly known as hidden glutamate, because yeast extract also contains a proportion of glutamate and thus enhances the umami taste profile of foods. However, according to the German Food Labelling Ordinance (LMKV), products that contain yeast extract can be labeled "without flavor enhancers", unlike products that contain monosodium glutamate.

The production process

First of all, a distinction can be made between two product groups: emulsion-based recipes for structure-free, emulsified products such as cold cuts and sausages, and textured TVP-based recipes for minced meat-like and chunky, coarser products.

Emulsion-based recipes (structure-free, emulsified products)

First, the basic mixture is produced – comparable to the production of a basic emulsion in sausage production. For that step the use of a cutter is the only way to go. Nothing has to be chopped but only the high knife speeds of a cutter can generate the shearing forces necessary for emulsification to produce a firm and cooked sausage-like mass with a clean cut. The use of a vacuum atmosphere significantly increases the emulsifying performance during the cutter process. It also ensures that the end product does not have any air bubbles in the cutting section, which has visual advantages and also increases the shelf life. Depending on the desired end product, the inlay is then mixed in during the mixing process or granulated at the slower knife speeds. The

Depending on the requirements, stable emulsification can be achieved in the cutter by high knife speeds and shear forces – intensive mixing and hydrogenation can be realized by backward rotating knives.

temperature control in the process is similar to sausage production by adding flaked ice. For particularly tough mixtures, drives with a higher torque are optionally available. In order to shorten batch times even further and to enable fully automatic operation, dosing systems for liquid and solid ingredients can also be integrated. This has the additional advantage that the production areas remain dust-free. The product ejector ejects the very tough and sticky mass reliably and almost residue-free.

Formulations based on textured proteins (TVP)

The production process takes place in three steps: Preparation of the binding emulsion, hydrogenation of the textured protein and mixing of these two components with the other recipe components. The challenges in the production process are especially the production of the binding emulsion and the hydrogenation of the dry TVP. In its initial state, the TVP has a moisture content of less than 15% and only through water absorption does the desired meat-like structure develop, which is required for the production of schnitzel and burger analogues.

Throughout the industry, cutters are used almost exclusively for the production of binding emulsion. High knife speeds and shear forces accelerate the emulsification of ice water and binding agent enormously and lead to high quality. Either mixers or cutters are used to hydrogenate the TVP. Under vacuum, the water is absorbed much faster. Both machine types are also used for the final mixing of the two components and other additives.

The advantages of using one cutter for all production steps are the smaller space requirement when using only one machine and especially discharging. The very tough and sticky mixture adheres strongly and must be discharged mostly manually when using a mixer – this costs a lot of time and significantly increases the risk of contamination. With the ejector of the bowl, a product yield of almost 100% is achieved without any further effort, as the product ejector of the bowl simultaneously scrapes the material of the bowl.

The exclusive processing in the cutter may seem strange at first sight – in the final production step it should only be mixed and not shredded. However, in the mixing process, the knives run backwards and thus without cutting action to the product. The same applies to the hydrogenation of the TVP under vacuum. Depending on requirements, high knife speeds and shear forces in normal cutter operation can thus ensure fast and stable emulsification or pure mixing by reversing the knives. Optionally, the temperature can be controlled at any time by indirect or direct cooling (CO_2/LN_2) or heating and kept within the optimum range for the subsequent shaping of products such as hamburger patties, nuggets, bars, "meat" balls or similar products. In order to shorten the batch times for those products even further and to enable fully automatic operation, automatic dosing systems for liquid and solid ingredients can also be integrated.

Depending on the variety, difference and production quantity of the target products, it may be sensible to use the advantages of the cutter only for the production of the binding emulsion, then to produce the different end product batches in mixers and to set the target temperature for the further production steps, such as filling, forming or portioning.

Which machine when?

Whether only cutters or a combination of cutters and mixers are used in production, ultimately depends on two variables: the desired product variety and the planned production quantity.

Who has exclusively emulsion-based products in the portfolio, can do nothing with a mixer and is best advised with the cutter – no matter which production quantities you aim at. If TVP-based products are to be produced too, this can also be realized in the cutter without any problems. If large quantities of TVP-based products are to be produced or if the production is exclusively focused on this, the additional use of a mixer is recommended in order to shorten the batch times and to fill larger batches than in the cutter.

Conclusion

Meat replacement products have arrived in everyday life, and a continued growth can be expected.

From an economic point of view, the products also currently offer an even higher margin than their classic counterparts. Following the law of supply and demand, more and more vegetable protein suppliers are entering the market, which should lead to falling prices in this commodity market in the foreseeable future. This means that the margins on the end products will continue to rise, whereby they will become cheaper and thus more interesting for even more consumers.

The potential product diversity is far from exhausted. More and more start-ups are entering the market with increasingly sophisticated products – from steak substitutes and breakfast ham to vegan salami and pet food.

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