Food extrusion

Twin-screw extrusion of plant-based meat

Twin-screw extrusion processing is considered a key technology for the continuous production of plant-based meat products. The main goal of this process is to impart a fibrous, muscle meat-like texture into plant protein-based formulations. Two different types of products can be produced with this technology: **High Moisture Meat Analog (HMMA) and texturized vegetable protein (texturized proteins).**

Texturized proteins are defined as dry and brittle products that have a porous structure that transforms into a fibrous, meat-like texture upon rehydration. HMMAs are soft and moist products with a directly visible fibrous, muscle-meat-like texture. After extrusion, HMMAs and texturized proteins are further processed with conventional meat processing operations such as marinating, shredding, and blending and can be used as a plant-based meat alternative in many different types of convenience products.

Texturized protein and HMMA products can be manufactured using the same twin-screw extruder despite their different product characteristics. As shown in Figure 1 and Figure 2, the different product types can be achieved simply by varying the die type and the water content used for the particular production process.

High moisture meat analog

The twin-screw extrusion process for HMMA is typically operated at water contents between 40 and 80% with a cooled slit die attached to the extruder (Figure 1). Typical extrusion temperatures range between 100 and 180 °C, while the temperature of the cooled slit die must be kept at < 100 °C to avoid structural distortion due to the evaporation of water. The formation of the characteristic product texture is determined by shear-induced structuring of plant protein formulations in the cooled slit die. The flow characteristics in the die determine the final product texture.

Texturized vegetable protein

The twin-screw extrusion process for TVP is typically operated at water contents between 15 and 30% with a strand die nozzle attached to the extruder (Figure 2). Extrusion temperatures are similar to HMMA processing, while the temperature in the die nozzle is kept at T > 100 °C to promote the evaporation of water. The formation of the characteristic product texture of texturized proteins is determined by pressure drop at the die exit leading to the evaporation of water and expansion of the product.

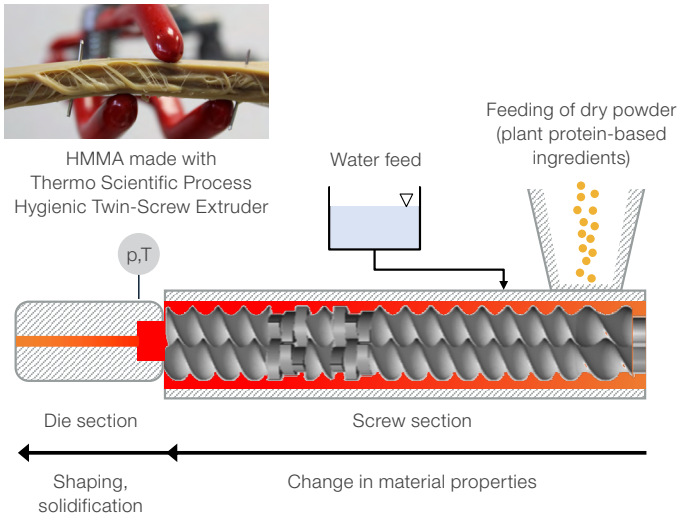

Figure 1: Process set-up for High Moisture Meat Analog (HMMA). Click here to watch the extrusion process for HMMA in action.

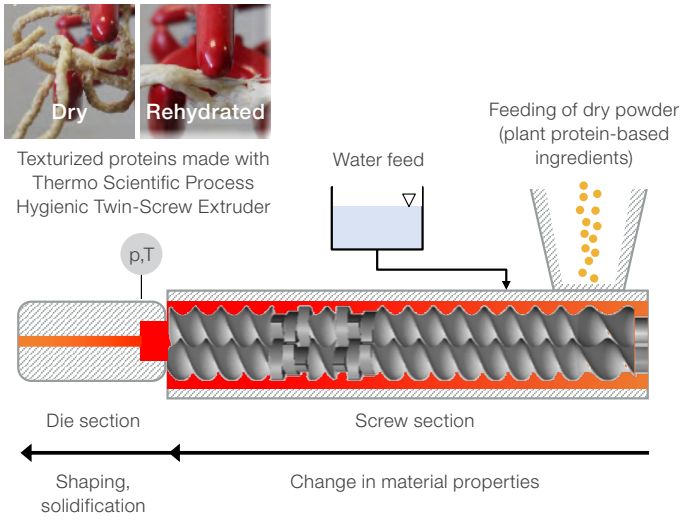

Figure 2: Process set-up for texturized vegetable protein. Click here to watch the extrusion process for this application in action.

Solution for application testing and process development

While the global demand for plant-based meat alternatives continues to grow at a rapid pace, many consumers still lack variety in marketed products, especially in terms of meat types and protein sources.[1,2] Therefore, to support the demand for plant-based meat, new products need to be developed that can cope with consumers' demands.

Thermo Scientific™ Twin-Screw Extruders offer a modular solution for application testing and process development from lab- to pilot-scale. All extruder sizes can be equipped with a *modular cooled slit die* for HMMA and a *strand-die nozzle* for texturized proteins production. These setups allow to create a wide range of meat-like textures depending on the combination of formulation, process conditions (e.g., temperature), and die geometry (e.g., die design). In addition, the compact and modular design, as well as the intuitive operation of our twin-screw extruders, enable our customers to save resources on application testing and accelerate process development. An overview of the preferred application for our hygienic twin-screw extruders is given in Table 1.

References

1. Plant-based Meat: Global Markets, November 2020, BCC Publishing Staff (Report Code FOD098A)
2. Szejda, K., Urbanovich, T., Wilks, M., Accelerating Consumer Adoption of Plant-Based Meat: An Evidence-Based Guide for Effective Practice, Febuary 2020, The Good Food Institute

Table 1. Hygienic twin-screw extruders comparison

			
Hygienic twin-screw extruders	Thermo Scientific™ Process 11 Hygienic Extruder	Thermo Scientific™ Process 16 Hygienic Extruder	Thermo Scientific™ TSE 24 Hygienic Extruder
Typical throughput*	0.02 – 2.5 kg/h	0.2 – 18 kg/h	1 – 50 kg/h
Dimensions L x W x H	820 x 480 x 340 mm	1230 x 690 x 1120 mm	2252 x 735 x 1230 mm
Specific torque	9.4 Nm/cm^3	9.2 Nm/cm^3	8.0 Nm/cm^3
Recommended for	• Material testing • Product development • Limited amount of material	• Material testing • Product development • Fast sample prototyping	• Continuous manufacturing at pilot scale • Multiple TSE 24 extruders to reach production scale and cope with downtimes or dedicate machines to specific, allergen-containing formulations

* Depending on formulation

All product contact parts are made of hygienic grade steel (X15TN) and allow you to meet GMP compliance with access to full validation (e.g., FAT, SAT).

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