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Mini Review

Structuring Meat Analogues Using Extrusion: An Insight

Navneet Singh Deora[1]* and Madhuresh Dwivedi[2]

[1]Ingredients Innovation and Research, Jubilant Foodworks, India

[2]Department of Food Process Engineering, National Institute of Technology, Rourkela, India

***Corresponding Author**: Navneet Singh Deora, Ingredients Innovation and Research, Jubilant Foodworks, India.

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Abstract

In the recent time, drive towards the sustainable and healthy foods have accelerated the research in the domain of plant protein-based meat alternatives. Key challenges are witnessed in the area of product development and scale up to replace the meat functionality in terms of sensory attributes, fibrous nature and overall acceptability. Plant based protein source can fulfil the growing demand of the customers seeking healthier and high protein options with characteristics similar to meat. Product development needs a consortium of entrepreneurs, scientist for the development of meat alternatives considering the larger impact on the environment by the use of animal derived proteins. This mini review aims of highlight current approaches for the meat analogues development with major emphasis in the extrusion technique.

Keywords: *Meat Analogues; Extrusion*

Current approach for the meat analogues

Meat proteins are exemplified by a prominent fibrous structure. Globally there are two different fundamental approach to mimic muscle-meat type and create the fibrous structure similar to meat muscles. One of the approach is bottom up strategy and another approach is top down [1,2]. The details of the approach in depicted in the figure 1. Bottom-up strategy aims to work on the key structural elements which are subsequently assembled into larger products. Another approach is top down approach which aims of create fibrous structure by structuring biopolymer blends using techniques like extrusion. Top down approach like extrusion is more scalable in nature however the bottom up approach closer to the structure of meat. In this article, we limit our discussion on the extrusion technique.

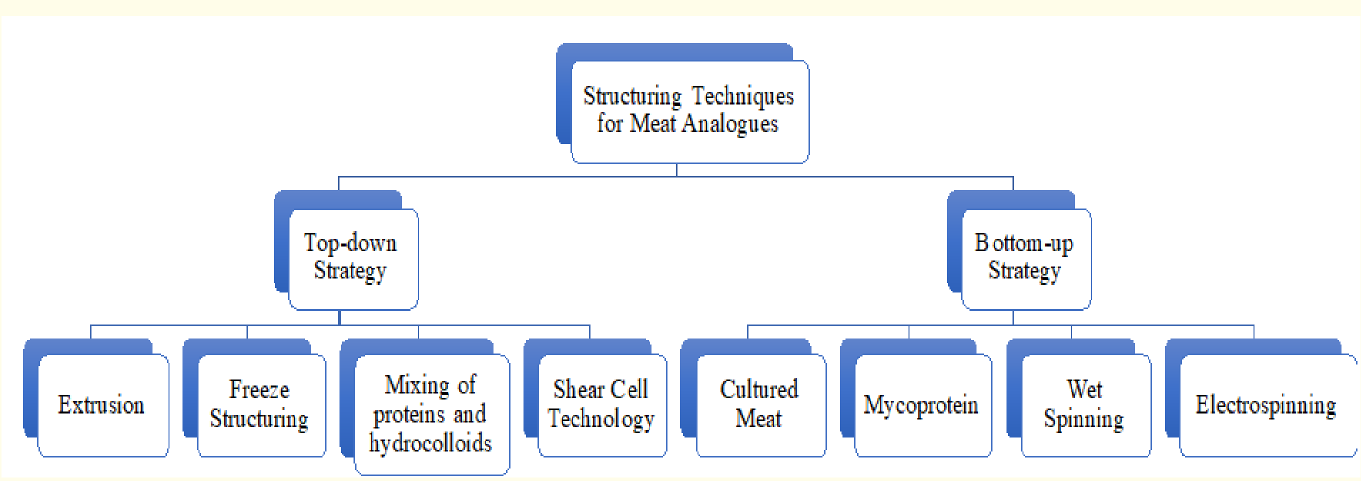

Figure 1: *Different approach for meat analogues structuring.*

Basic set up of extrusion to develop meat analogues

Extrusion cooking allows structural development by use of the source of starch or proteins at low or high moisture conditions. For meat analogues, high moisture extrusion technique is employed to create the fibrous structure. The basic set up with the process conditions is described in the figure 2. During high-moisture extrusion cooking, the plant based protein, water and other ingredients are separately fed to the extruder barrel and adjusted to moisture contents of 40% up to 70% [3,4]. Post mixing zone, the cooking zone melts the protein at the typical temperature range of 130°C and 170°C under high shear and pressure conditions. At the extruder end, one of the key element for the formation of the fibrous structure is the cooling die. Cooling die is required to bring the temperature below the critical temperature of the viscous protein melt. This zone of the extruder is Texturization zone where the fiber formation happens with the spinodal phase separation as depicted in figure 2.

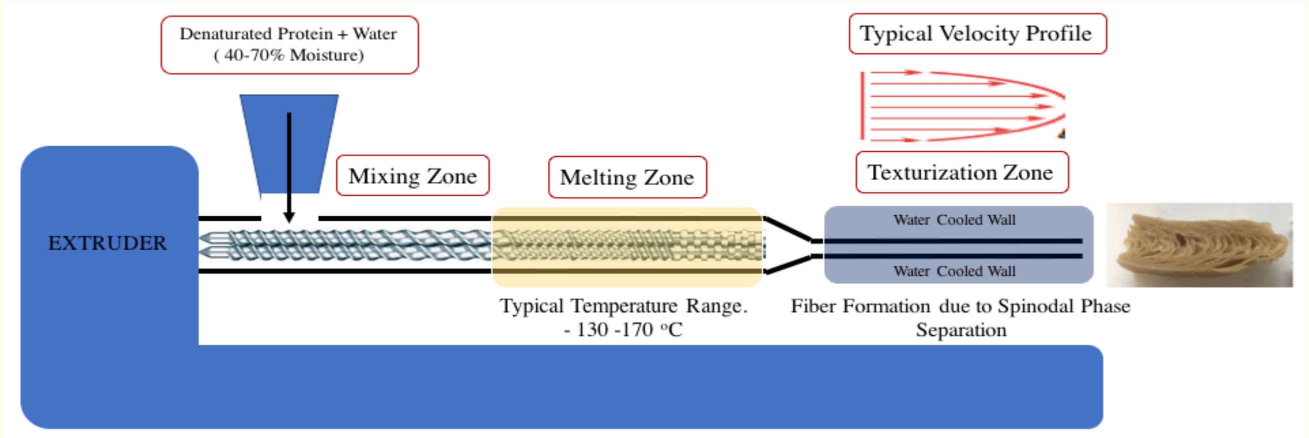

Figure 2: *Basic set up of extrusion to develop meat analogues.*

Process parameters for extrusions

Control of the process parameters is of paramount importance for the formation of fibers. Figure 3 highlights the key independent parameters for the extrusion. Parameters can be classified as machine, process and feed parameters. Understanding of all these parameters are critical for the product development.

Figure 3: *Independent properties of extrusion to develop meat.*

How structure are formed during extrusion: current understanding

There are multiple papers that defines the origin of fibers or structuring in meat analogues [1-5]. Some studies suggest that formation of the structure on the basis of restructuring of the denatured proteins and due to the shear flow in the cooling channel at the extruder end. In contrast to this explanation, recent work has highlighted the formation of layered structure due to the phase separation. Here the authors have suggested that phase separation is between the water rich and protein rich domains of the aqueous protein melt. At this stage, it is understood that the velocity gradient causes the separated phases to align in layers along the flow direction. It could be assumed that the proteins are first molten in the cooking zone and then fused to each other to create a large elastic protein mass that is stretched in the extrusion direction to form the observed fibers. However, it is also important to understand and identify the sub-critical temperature of different sources of proteins and fibrous structure development.

Conclusion

Understanding of the High-moisture extrusion process is still limited. Additional studies need to conducted to develop understanding about the fiber formation. However, it is so far understood that we need to have an accurate extruder parameter for the production of meat analogues with a fibrous structure. Food industry should promote the meat analogues from a niche market to a sustainable and larger market in the future.

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