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Nonfat Dried Milk and Skim Milk Powder – All the same or different?

Nonfat Dry Milk (NFDM) and Skim Milk Powder (SMP) are both produced by water removal processes (evaporation, followed by spray drying) to produce dry, free flowing, shelf stable powders, have similar compositions, and both products are used in a wide range of dairy and food applications. However, differences in the original milk quality, manufacturing steps, equipment used, and storage conditions for the finished product can result in intentional and non-intentional differences within and between each these products. Hence it behooves the manufacturer and user to understand what contributes to differences in these products in order to control the production of and/or selection of milk powders that have the desired properties for specific end uses.

Product Standards

Nonfat Dry Milk is defined by the United States Code of Federal Regulations (CFR21, Sect 131.125) as the product made from the concentration and drying of skim milk whereas Skimmed Milk Powder (SMP) is defined by the Codex Alimentarius (Codex Stan 207-1999). While the general provisions for moisture content, fat content, and methods of manufacture sound quite similar, the SMP standard has two other provisions that NFDM does not include. First, it is specified that there is a minimum protein content in the solids nonfat portion of 34% and this can be achieved by using protein standardization ingredients (lactose, milk permeate and milk retentate). In some cases, SMP will contain a lower protein content that NFDM depending on the original milk protein content in the skim milk in which the NFDM was produced. But because of the protein standardization allowance in SMP, the protein content of SMP is typically standardized (upwards or downwards) to a constant value close to the minimum of 34% on a solids nonfat basis. Secondly with the Codex Standard for SMP there is an allowance to use specific food additives (stabilizers, firming agents, acidity regulators, emulsifiers, antioxidants, anticaking agents. As a result, all NFDM can meet the SMP standard but not all SMP can meet the NFDM standard. SMP is primarily made for export. Further, in the US, only NFDM (not SMP) is allowed in foods containing a standard of identity and SMP can be used in the US only in non-standardized foods.

Milk Quality

While there are limits to bacteria count and somatic cell count in raw milk supplies destined for manufacture into NFDM or SMP, variations within the allowed limits may influence the powder quality. Higher bacterial

counts and somatic cell counts can elevate proteolysis (protein breakdown) and off flavors that can translate into the final powder and impact other functional properties (e.g. heat stability) of the final powder. Additionally, differences in the types of bacteria found in raw milk supplies may influence finished powder quality (i.e. differences in heat resistance of bacteria or their assocated enzymes can affect powder quality). Methods of testing may also be important particularly for spore count detection in raw milk and milk powders (Kent, et. al., 2016).

Heat Pretreatments

In addition to the potential compositional differences associated with these two standards and milk quality-differences, pre-heat treatments prior to concentration and drying of the milk are used intentionally to alter the functional properties of these products for specific food applications. These additional heat treatments (beyond pasteurization) increases the amount of denatured whey protein content and are associated with differences in functionality of the final milk powder that are preferred for some applications. For example, in bakery applications, milk is heat treated at approximately 195 F (90C) for 15 seconds prior to concentration and drying to result in milk powders with relatively high whey protein denaturation (WPNI < 1.50) and is classified as a "high heat" milk powder. For applications in cheese making or recombined milk, "low heat" milk powder (minimal whey protein denaturation (WPNI > 6.0)) is preferred and so the milk is given the minimal pasteurization heat treatment (161 F (72C) for 15 seconds) only prior to evaporation and drying.

Several factors during concentration and drying can also influence milk powder properties. Feed solids content, atomizer type and conditions, and dryer type and conditions can all impact powder particle properties (e.g. particle density, particle size distribution, moisture content, and air content of the powder). Variations in these powder characteristics can impact important functional properties such as bulk density, flowability, dispersibility, sinkability, and solubility) that are important to end users. In addition, more recent work has shown that operating conditions, frequency of cleaning, and types of equipment used may affect spore counts in finished products.

Concentration and Drying:

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Storage

NFDM and SMP stored in dry, cool conditions can have a shelf life of 18-24 months or more. However, milk powders are hygroscopic and can cake or become lumpy under storage in more humid environments. Under elevated storage conditions browning reactions can occur to effect the color and functionality. Con

ditions of evaporation, spray drying and storage conditions for milk powders can result in variations in desired sweet aromatic compounds characteristic of milk flavor and the appearance of cardboard and cooked off flavors.

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