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PROPERTIES AND GENERALIZED SCHEME FOR PRODUCTION OF MILK POWDER

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ABSTRACT: Presently, the functional qualities of milk proteins have led to milk powders, being mostly regarded as food components. When milk powders are maintained, numerous physicochemical problems develop, the most of them being generated by the lactose glass transition. They have significant effects on milk powders physical (flow ability) properties. First, powder particle surface microstructure and chemical composition are altered by lactose crystallization. As a result, milk powder's capacity travel is reduced. Milk proteins solubility is harmed because their structural integrity has been destroyed. Additionally, caking and particle collapse occur, and these processes primarily decrease the physical properties of milk powders(Flow capability and density). The unfolding of proteins, which reduces solubility and may also be encouraged by the mechanical stresses that appear. Lastly, enzymatic and chemical reactions (Maillard reaction) occur in order, implementing molecular mobility. Milk powder's solubility is mostly decreased by protein interactions and aggregations, which are enhanced by the Maillard process and oxidation. Emulsifying and foaming characteristics are also decreased by the Maillard process. Additionally demonstrated that milk components, time, and their physical state. The main factors that have been considered are the relative humidity and temperature of the storage.

KEY WORDS: Milk Powder, Generalized Scheme, Storage, Flow ability, Density, Flow Ability, Particle Size, Insolubility.

I.INTRODUCTION

A nutrient-rich food is milk. There should be very little germs in raw milk from healthy cows. Raw milk from healthy cows can be consumed to lower health risks, but it quickly spoils. In order to increase the shelf life of milk, mankind has undertaken several attempts to concentrate and preserve it throughout history. In the thirteenth century, Marco Polo said that Kublai Khan's soldiers carried dried milk with they performed searches [1]. There is an approach that some of the milk's fat was removed before drying, and the milk had been dehydrated using sun heating. In 1832, Russian scientist M. Dirchoff developed the first practical commercial method of producing Milk Powder (MP). Birdseye produced a solid in 1850 by concentrating milk with additional sugar. T. S. Grimwade submitted a patent application in 1855 for a method of drying milk, the fact that William Newton had already received a patent in 1837 for a vacuum-drying method [2].

In the nineteenth century, the industry for concentrated and dried milk products was made available when a French inventor by the name of Nicolas Appert described his process for concentrating and drying milk. The formation of dried milk all through the final part of the nineteenth century includes the expansion of different dry products to concentrated milk [3]. Drinks, cereal items, and sugar were all added, either alone or in combination. For individuals without direct access to suitable refrigerated facilities, the MP is the perfect solution. MP is produced by removing milk's water content [4]. The essential objective of changing milk into MP is to change the fluid, transient natural substance into an item that can be put away for a long while, ideally for a considerable length of time, without significantly compromising its quality.

The milk powder is applicable to a wide range of sectors, including those that produce infant formula, nutritious foods, confectioneries and bakeries. Due to its characteristics, including high-quality maintenance, less storage space is needed, and requiring less transportation, Milk powder(MP) production has grown to be a significant portion of the dairy industry and is predicted [5]. MP also results in appealing economics and convenience during the production of composite foods both domestically and commercially. Butter traditionally served the same purpose for milk the same way that nonfat dry milk did for milk solids. The primary objective of the industry's goal is to create dry items that aren't much more damaging than equivalent liquid goods when combined with water. The same dried milk product has taken on a wide range of names [6].

For instance, dehydrated skim milk, nonfat dry milk solids, dried skim milk, and Skim MP (SMP), are some of the other names for nonfat dry milk. According to their identities, powdered or dried whole milk is widely used to refer to dry whole milk, dry buttermilk, dry cream, and other products. Spray-drying is the common method used nowadays, to create MP [7]. Drum (roller) drying and freeze drying are further options for drying milk. By freeze-drying, almost all of milk's nutrients are preserved, but the process is very costly. The main markets for items made from dried milk are China, the US, and France. The main exporter of MP is New Zealand [8–9]. Although the biggest producers of MP are the US, Argentina, Australia, and European areas, the biggest exporters are not these countries. That are most importing the MP are the UK, Germany, the Netherlands, and Brazil [10].

II. TECHNOLOGY OF MP MANUFACTURE

All of the water from the dairy products used in the MPs has been completely eliminated, and preventing the growth of microorganisms. According to Figure 1, MP is produced by a series of processing procedures including receipt, clarifying, storage and cooling, homogenization, drying, standardization, heat treatment, evaporation, and packing.

The quality of the MP is significantly impacted by the use of raw milk. Chemical, sensory, and bacteriological quality should be high in milk. Before choosing raw milk, chemical and bacteriological testing are conducted at the receipt area. The solubility of MP is negatively impacted by raw milk's high microbial load. To prevent contamination by bacteria and particle matter after delivery, the milk may be clarified or given antibiotic treatment. Nowadays, low-heat powders with extremely low bacterial loads are made using the microfiltration process. Clarified milk is kept refrigerated until it is eventually heated-treated to prevent the following development of psychoactive bacteria.

Considering the amount of cream or skim milk added, raw milk is standardized. From the UF of skim milk, retentate or permeate are added either to increase or decrease the protein level in order to standardize the composition. All harmful organisms are destroyed by the heat treatments. It also removes the presence of saprophytic microorganisms, deactivates lipases, and b-lactoglobulin's SH groups are activated, which improves storage stability against autoxidation.

Prior to drying, milk is concentrated, typically it utilizes a continuous multiple effect evaporator. Particularly in the case of powders that have been spray-dried, the concentrate is not always homogenized. Concentrated milk is homogenized to improve its viscosity, which causes coarse droplets to form atomization. Typically, roller drying or spray drying is used to dry condensed milk. There have been initiatives to create whole new drying processes. For the industrial manufacture of MP, mainly spray-drying and roller-drying methods are used.

The heated drum surface directly contacts the concentrated milk being dried with a roller, which led irreversible modifications such protein denaturation, Maillard's browning, and lactose caramelization that reduce the powder's solubility. Even though the dairy industry has used spray drying since around 1800, until 1850, the first milk drying on a large scale was made practical. However, the final result could not be regarded as pure because each method needed the addition of alkali or sulfuric acid, sugar. German Mr. Stauf began in 1901, presented an application for one of the first patents for spray drying. He used nozzles to spray milk into a chamber filled with heated air.

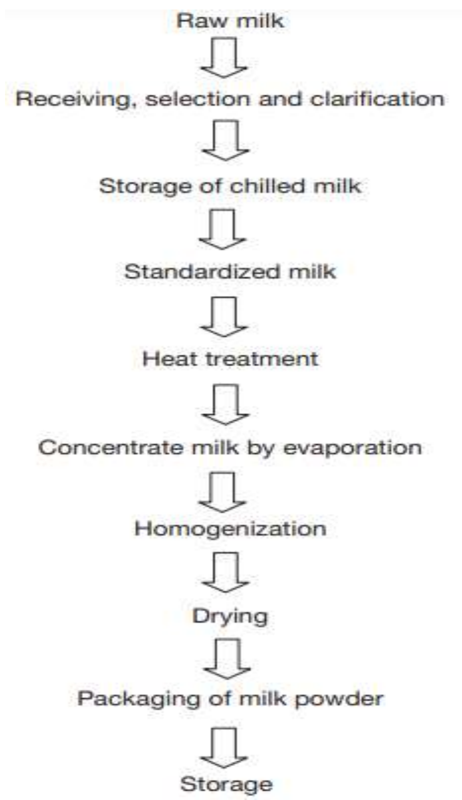

Fig. 1: GENERALIZED SCHEME FOR PRODUCTION OF MILK POWDER

However, the first notable advancement was the United States in 1913 when American Mr. Grey and Danish Mr. Jensen created a nozzle spray dryer and proceeded to the market drying services and weight produce. In 1912, the German Mr. Kraus invented the first rotary atomizer. However, Atomization didn't really advance until the Danish engineer Mr. Nyrop submitted an international patent application in 1933. These pioneers provided the foundation for the present MP industry, and as a result, significant advancements have been produced. Because of that, modern spray-drying sometimes, the design of machinery is quite technological and advanced, and it can be rather complicated.. The air disperser, which is located at the top of the drying chamber and contains the atomizing device, and pushed from the product feed tank to accept the feed. Before passing through the air heater and air disperser, using a filter, a supply fan pulls drying air from the surroundings. When the atomized droplets come into contact with the heated air, evaporation occurs while the air is simultaneously cooling. A lot of the product that has been dried with a spray in the drying chamber spray to the bottom, where it is cooled and circulated by air.

In order to separate the fines, the air must be circulated through cyclones, or particles with a tiny diameter, from the other particles since they will remain in the air. Through a locking mechanism, the fines enter the pneumatic system as well as exit the cyclone at the bottom. With the help of the exhaust fan, air is transferred from the cyclone to the atmosphere. Separation of the two powder portions using a cyclone after being generated in the pneumatic system for cooling and transporting, before to being bagged off. An indicator for the temperature of the air entering and leaving the system is included in the instrumentation. Through controlling the oil or gas supply to the air heater as well as the steam pressure, the temperature of the air entering the system is automatically adjusted. Enhancing the given feed to the atomizing device's quantity, the system automatically regulates the temperature of the air exiting the system.

Milk drying using the spray-drying procedure is now widely accepted. To preserve excellent taste, body properties, following drying, in order for the powder have a long shelf life, it must be quickly cooled to a temperature below the melting point of fat. SMP is A somewhat different process than complete MP is used to manufacture, The least harmful heat-induced changes, such as denaturing of serum proteins, are achieved by pasteurization, it is the heat treatment at low temperatures that is most effective. It is possible to concentrate milk to have increased solid contents without homogenization. Additionally, dry mixing is used to include vitamin A preparations. SMP should be immediately cooled since it is susceptible to changes created on by heat and humidity that might degrade the quality of the powder. The right containers capable of protecting powder from moisture, air, light, etc. should be used to pack.

Examples of typical wrapping materials include paper, Metal barrels with polyethylene bags inside, multi-layer polyethylene-lined boxes or bags, tins with an aluminium foil coating on the contact surface are examples of packaging with several levels. The bulk density of the product must be taken into consideration when estimating the amount of wrapping material since processing characteristics and methods have a significant impact. The product is packaged in a partial vacuum (4.0–5.3 KPa) or an atmosphere of inert gas, mainly nitrogen, when it is intended for long-term preservation, to prevent oxidative changes to fat and other components. Milk power that has been properly manufactured and packaged has a lower oxygen concentration is kept at ambient temperatures.

III. PROPERTIES OF MP

The whey protein nitrogen (WPN) index, flowability, dissolution, insolubility, particle size, shape, and surface density of MP are some of its key characteristics. These characteristics determine the efficiency and applicability of milk powder in particular processes.

Particle Size

The physical features of MP like as appearance, reconstitution, and flow may all be affected by the particle size. Powder reconstitution characteristics in milk powder can be impacted by particle sizes. Different particle sizes can cause the powder to stratify the ability of the dry product to reconstitute will be impacted by the greater solids content at the top. The particle size of MP can also affect its wettability and dispersibility. As the fraction of small particles below 90 mm rises, dispersibility decreases. The size and form of the particles can affect flowability. Smaller particles have an ability to move more slowly than larger. The level to which the particles are packed strongly depends on their size and design, in which the powder's bulk density will be affected. It is common to find fat globules, casein micelles, and serum proteins in the continuous mass of amorphous lactose and other low-molar-mass components that make up the MP particles. When the particle surfaces are not in touch, occluded air vacuoles are also present in the particles.

Spray-dried particles surfaces can be wrinkled in addition to typically smooth. Wrinkles may be increased by factors such as hotter intake air and greater temperature differential between hot air and powder particles. The various drying conditions that the individual particles were faced with can be responsible for the occurrence of particles with diverse morphologies in the same sample. The properties of the milk, the circumstances of processing, and the kind of equipment utilized during the drying process may all affect particle size. Powder particle size may be controlled by modifying the atomization parameters, which also affect the form and size distribution of the final product. In comparison to pressure nozzle atomization, centrifugal atomization produces stronger dried-spray particles.

Particles of spray-dried powder are typically spherical, and have sizes between 10 and 250 mm. The required particle size for rapid dispersion is between 150 and 200 mm in diameter. Agglomerated MP contains smaller identifiable small particles, more irregular-shaped particles. Air is incorporated between the powder particles are often as a result of agglomeration. Water is added during reconstitution to replace the air. As a result, the agglomerates easily dispersed and dissolve.

Density

A particularly complex product feature that is essential for both functional and economical reasons is the bulk density of MP. In order to save money on shipping and packaging, bulk density is desirable. However, agglomerated items low bulk density has an impact on other powder features, such as flowability and instantaneous properties. Typically expressed in g/ cm3, kg/ m3, or g/100 ml, bulk density is the weight of a volume unit of powder. The volume of 100 g of powder, after being subjected to compaction by standardized tapping, more often measured to estimate bulk density. From 0.18 to 1.25 g ml1, nonfat dry milk's bulk density has a large variations. Nonfat dry milk that has been roller dried weighs between 0.3 and 0.50 g ml1, whereas regular spray-dried nonfat dry milk weighs are between 0.5 and 0.60 g ml1. Particle density (occluded air and solids density) and interstitial air combine to produce the final powder's bulk density. The amount of interstitial air (air between the particles), the solids density, the amount of occluded air (air inside particles) or the particle density are only a few of the numerous variables that can affect bulk density. One of the most crucial elements in regulating bulk density is occluded air.

Flow-ability

A powder's flowability refers to its capacity to move through the air easily without lumping or aggregating. It may be calculated as the amount of time required for a specific amount of powder to exit a rotating drum. Electrical charge, density, and particle shape all affect flowability. Particles having a diameter of 90 mm more accessibility than smaller ones. The addition inert, ultra-fine particles, including SiO_2, Na–Al–silicate, or $Ca_3 (PO_4)_2$or $Ca_3 (PO_4)_2$, can significantly increase flowability. For example, in MP for coffee machines, such enhancements are used.

Dissolution

MP is distributed when it is dissolved in water, that it will take some time for the powder particles to entirely absorb. The colloidal particles (casein micelles with fat globules) then spread in the fluid when the soluble components dissolve. This will take some time to complete.. A small portion often doesn't dissolve. It can take a day or two for a solution to attain equilibrium in terms of composition, particularly the distribution of salt. The reconstituted milk can be heated to 50–600°C, then cooled more to speed up the process.

Insolubility

There are several methods for estimating insolubility. Under controlled circumstances (concentration, temperature, stirring time and intensity), centrifuging after the powder has been dissolved in water. For the purpose of determining the quantity of insoluble residue, the supernatant is removed, water is added, and then centrifugation is performed at that point. The insolubility index is the result. Aggregates of coagulated protein in WMP that contain milk fat globules may float to the top; the amount involved exceeds the sediment. As a result, the insolubility discovered is highly dependent on the technique.

Whey Protein Nitrogen Index

It determines the intensity of the heat treatment used to prepare the powder. Whey proteins can be modified or denatured by heat. Whey proteins can be changed or denatured by heat. The test counts the quantity of whey protein that is undenatured in the powder. A high number indicates that the product is more soluble when moderate centrifugal forces are applied under the given conditions, and that the whey proteins are more soluble. The unit of measurement for undenatured WPN is milligrams (mg) per gram of nonfat MP with a moisture content of 3.16 percent. After precipitating the reconstituted milk with NaCl, Filtration removes casein and the heat-denatured whey proteins. A number of factors including the proportion of whey proteins, the development of proteins from the addition of HCl reduces turbidity. A spectrophotometer measured to a wavelength of 420 nm, measures the turbidity as a percentage transmittance. This reading may be immediately translated into milligrammes of undenatured whey protein N/g powder (WPN) by using the standard curve as an indicator.

IV.SENSORY EVALUATION OF MP

A Q10 model is frequently used to identify a reaction's temperature sensitivity. Q10 models may be used to forecast a product's quality, nutrient loss, and shelf life. If a product is kept at two temperatures that are 100 degrees apart the reaction will proceed 10^{0}C times faster. MPs, especially SMP, are produced in a large amount during the flush season and then utilized in reconstituted form during the lean season to sustain the milk provided. It is now a significant exportable product. According to its microbiological, physicochemical, re-constitutional, organoleptic, and reconstituted milk (to produce reconstituted milk, when the powder is added into water) capabilities, MP has been evaluated. Basic components of quality requirements are these characteristics. It is important to take measures to maintain the raw milk's basic characteristics while drying. Consumer acceptability of MP is significantly affected by evaluation of MP based on its sensory properties.

V.CONCLUSION

When reconstituted, a high-quality SMP should taste comparable to fresh skim milk, which often has a flat tasting since it has minimal fat. Consequently, the taste is pleasant, sweet, and, clean, and it may taste a little cooked or heated. Stale/storage, neutralizer, oxidized, and consumed flavour defects are typical with SMP. The consistency of instant SMP is rather than granular, and it flows easily, like corn meal. SMP produced using the spray-drying technique has properties that are comparable to corn meal's flow and is extremely fine, light, and dusty. Due to MP being subjected to very high heat during processing, a scorched off-flavor develops. The SMP texture issue linked the most often occurrences is cake creation. Sometimes a product's defect is extremely severe that it resembles a rock. SMP should have a consistent color and should be free of any foreign particles, scorched particles, or browning. A colorful glowing or creamy white color should be present on the product.

VI.REFERENCES

[1] Chan L, Danial RM, Corlbear T (2019) Detection and impact of protease and lipids activities in milk and milk powder. A review. Int Dairy J 13: 255-275.
[2] Henning DR, Baer RJ, Hassan AN, Dave R (2016) Major adrancea in concotrated and dry milk products cheese and milk fat-based spreads. J Dairy Sci 89: 1179-1188.
[3] Rosinthol I (2016) Milk and dry products properties and processing. Balaban Publisher VCH, New York, USA.
[4] Thomas CEM, Scher J, Banon DS, Desebry S (2014) Milk powders ageing: Effect on physical and functional proportion. Crit Rev Food Sci Nutr 44: 297-322.
[5] Eckles CH (2011) Milk and milk products: Technology, chemistry and microbiology. (4th edn), Tata McGraw-Hill Publishing, New Delhi, India.
[6] Codex S (2009) Codex standard for milk powders and cream powder. Codex Stan, Codex Alimentarius commission p. 270.
[7] EAS (2006) Dried while milk and skimmed milk powder-specification EAS, East African Community Standards p. 49.
[8] SDS (2008) Milk powder SDS, Sudanese Standards and Metrology Organization, Khartoum, Sudan. p. 108.
[9] SVGNS (2004) Standard for milk powders and cream powder. SVGNS, ST Vincent and the Grenadines Bureau of Standards p. 28.

[10] AOAC (2003) Official Methods of Analysis 17th. Association of Official Analysis chemist (AOAC). Washington D.C., USA.
[11] AOAC (2003) Official Methods of Analysis 15th Edi. Association of Official Analytical chemist (AOAC) Washington D.C., USA.
[12] AOAC (2000) Official methods of Analysis of AOAC international (17th edn). AOAC international, Gaithersburg, MD, USA. Official Methods p. 920
[13] Richard EL (2000) The reaction of the lactose with anthrone and its application to estimation of lactose in casein and other dairy product. J Dairy Res 26: 53-57.
[14] Rech C, Bhat SN, Berrut S (2000) Determination of water content in powder milk food chemistry 86: 457-464.
[15] Sabah Elkhier MK, Yagoub AA (2000) Quality assessment of milk powder packed in Sudan. Pak J Nutr 8: 388-391.