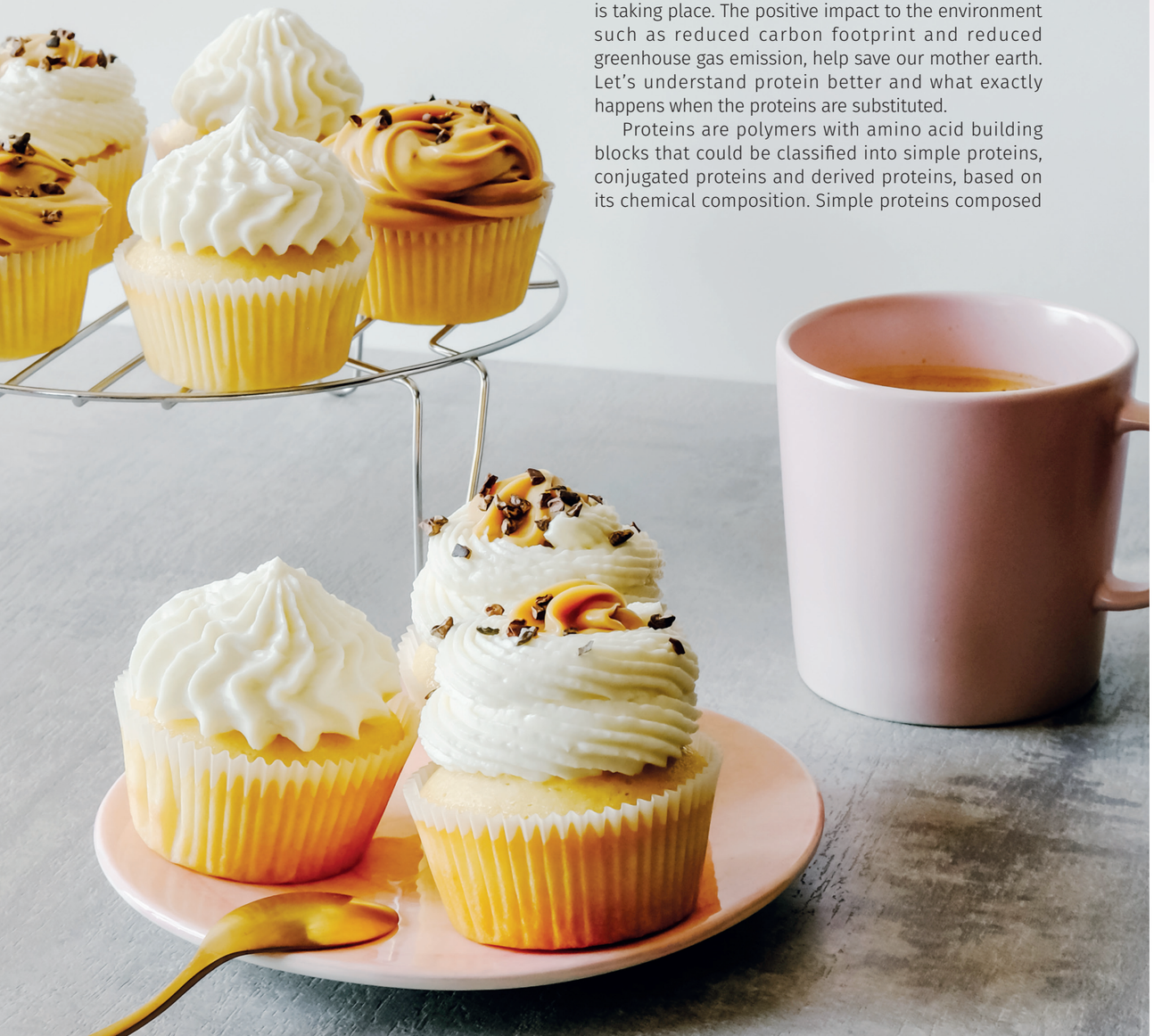
EMULSIFIERS & HYDROCOLLOIDS IN PLANT-BASED PROTEIN REVOLUTIONS

UNDERSTANDING THE FUNDAMENTALS OF PLANT PROTEINS, EMULSIFIERS AND HYDROCOLLOIDS ARE THE ESSENCE AT THE BEGINNING OF THE PRODUCT DEVELOPMENT ADVENTURE. BY **LAIYEE LEE**—ASSISTANT MANAGER, TECHNOLOGY, FUTURA INGREDIENTS.



THE revolution: the move from animal to plant proteins is taking place. The positive impact to the environment such as reduced carbon footprint and reduced greenhouse gas emission, help save our mother earth. Let's understand protein better and what exactly happens when the proteins are substituted.

Proteins are polymers with amino acid building blocks that could be classified into simple proteins, conjugated proteins and derived proteins, based on its chemical composition. Simple proteins composed of only amino acids with relatively simple structure. Conjugated proteins are simple proteins combined with at least one non-protein components. Derived proteins are manufactured from simple or conjugated proteins by physical or chemical process.

Proteins from plant and animal are significantly different in terms of its chemical composition and structure. Plant protein powders are pure amino acid chains while animal proteins are typically complex and comprised of conjugated proteins. Conjugated proteins are more functional owing to its naturally complex configuration. For example, in baked goods—there is ovalbumin in egg white that form foams easily and lipoproteins in egg yolks that gives good emulsifying properties; while in dairy beverages—milk proteins are phosphoproteins that helps with emulsion stability.

EMULSIFIERS AND HYDROCOLLOIDS ARE EFFECTIVE IN PROVIDING THE TECHNICAL FUNCTIONALITIES WHICH ARE VITALLY IMPORTANT IN THE DEVELOPMENT OF PLANT PROTEIN-BASED PRODUCTS.

Formulating with plant proteins could be complicated as it requires the support of other functional ingredients to obtain certain desired functionalities. Emulsifiers and hydrocolloids are in this instance effective in providing the technical functionalities vitally important in the development of plant protein-based products. In this article, we will cover their roles in protein substitution in plant protein beverages, vegan ice-creams and bakery products.

PLANT PROTEIN BEVERAGES

When formulating plant protein beverages, composition of dairy milk—fat, protein and sugar, is often referred to as the standard. Oil high in polyunsaturated fat, for example sunflower oil, is often added to improve mouthfeel and enhance the overall richness of the beverage. This healthier oil is always a good option, yet it raises the concerns of separation and emulsion stability as compared to typical milk fat that is higher in saturated fat that helps with fat crystallisation for shelf stability.

Apart from that, proteins are generally heat sensitive and possibly denatured upon heating, potentially causing phase separation and eventually sedimentation. To make plant protein beverages healthier, the products could be added with fibres and minerals, like oats and calcium respectively. These healthier formulations are however susceptible to physical defects such as sedimentation. There is also the fouling challenge when these particles are present in the heat processing line.

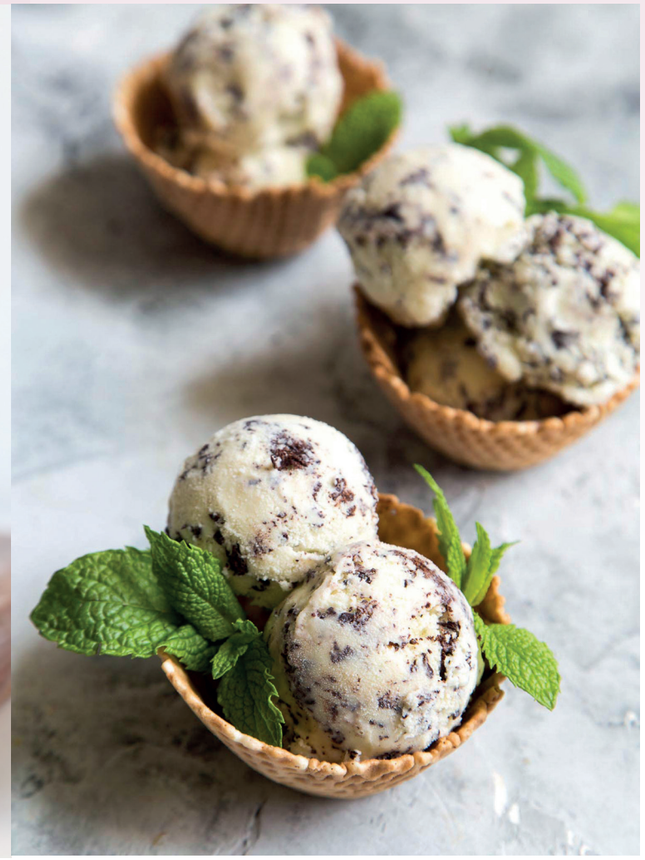
Emulsifiers such as mono- and diglycerides (MDG) help create uniformly fine fat globules during homogenisation, for example at 220/40 bar, that imparts creaminess to the plant protein beverages. MDG enhances fat crystallisation in the liquid matrix, hence stabilises the emulsion improving its shelf stability. In addition, MDG is effectively a grease in heat exchangers to delay fouling. Hydrocolloids such as gellan gum is good with particles suspension from its elastic and flexible network formed. The fluid gel keeps the beverage stable throughout the shelf life while imparting favourable organoleptic properties.

VEGAN ICE-CREAMS

Ice-creams are termed ice confection or frozen confection when the composition does not meet legislative requirement, for example its fat source or level, total solids and overrun level. It has long been a practice to replace milk fat with vegetable fat in ice-creams for several reasons, like cost savings and easier access to the fat sources. To make vegan ice-creams, the dairy-based milk solids non fats (MSNF) need to be eliminated too. This protein substitution is expected to cause changes in its texture and consistency. To avoid making vegan ice-creams that is dry and short in texture it is necessary to increase appropriate sugar composition to compensate the missing lactose with the addition of salt to balance out the missing minerals from the MSNF.

Another potential challenge in vegan ice-cream making is the taste that plant protein powder might bring into the finished product. Many claims that plant protein powder tends to be raw, beany or earthy. Selecting not just the right type but also the right source and origin of plant proteins are therefore crucial. The more premium vegan formulations tend to use plant milk as they contribute a unique sensorial profile that could potentially mask these flavours of plant proteins. Examples are unsweetened almond milk, coconut milk and rice milk.

Texturising system are added to vegan ice-creams just as its dairy counterparts for enhanced product performances. The emulsifier used is typically MDG which makes smooth ice-creams with good body and texture. The MDG interacts with fats to form fat aggregates required, giving desirable creaminess and overrun stability. This overrun stability from MDG together with the right combination of hydrocolloids give enhanced melting resistance and better security against temperature fluctuations within the cold supply chain, termed as the heat shock resistance.



SWEET BAKED GOODS

Both protein fortification and protein substitution with plant proteins are common in baked goods. Protein fortification with claims such as high, increased, enhanced, or rich in protein will need to be justified. For example, a minimum 25 percent increase in comparison to the original food is necessary in order to claim the food as "increased protein" in Australia and New Zealand. Some 4 percent plant protein addition to certain formulations could boost its overall protein content by 30 to 40 percent without many changes to the product. Another approach is to replace a certain proportion of dry ingredients, for example flour, with plant protein powder. If a higher level of protein is desired, more plant protein could be added with the formulation's liquid level adapted to accommodate its water binding capacity.

Egg protein substitution in bakery, particularly the making of vegan cakes, is challenging as the aeration source is bound to limited options of ingredients. The more direct application of this substitution is eggless cookies where the egg composition, approximately 74 percent water, 12 percent fat, and 13 percent protein—could be replaced with water, unsalted butter (vegan butter or margarine for vegan version) and plant protein powder respectively. Dosage of plant protein could be higher for protein fortification purpose. Emulsifier like sodium stearoyl lactylates (SSL) is added for batter emulsification and enhanced overall eating properties.

The more challenging protein substitution is replacement of wheat in the creation of gluten free products. The composition of wheat flour could be easily replaced but not its functionalities. It is therefore complicated to make gluten free bread as gluten is the key to its structure and characteristics. On the other hand, gluten free cake is possible with the help of emulsifiers and hydrocolloids. The direct addition of emulsifiers such as distilled monoglycerides (DMG), SSL and propylene glycol mono esters (PGME) impart crumb softness with fine and uniform crumb structure. These emulsifiers also improve freshness and delay the staling rate of gluten free cakes, while cake gel (activated emulsifiers in gel format) helps to enhance the aeration capabilities of the cake batter. Hydrocolloids such as xanthan gum and hydroxypropyl methyl cellulose (HPMC) are necessary to build the desired batter viscosity to give and maintain cake structure.

Developing plant-based products are interesting as one gets to explore various ingredients combination. The ultimate objective is to create a product that is well accepted, temptingly palatable, and shelf stable. Understanding the fundamentals of plant proteins, emulsifiers and hydrocolloids are the essence at the beginning of the product development adventure. The knowledge foundation ensures that we formulate with the right type and source of plant proteins, emulsifiers and hydrocolloids. Futura Ingredients offers technical support to advance product innovation and a wide range of texture solutions including Ekölite VITA Plant Protein series and Ekömul KREM texturising systems. Reach out to Futura Ingredients to expand the dialogue on your plant-based product developments and challenges. APFI