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Evaluation the potential of using plant-based milk alternatives in cake production – A review

Gamze Nil Yazici*, Tansu Taspinar, Mehmet Sertac Ozer
Cukurova University, Faculty of Engineering, Food Engineering Department, Adana, TURKEY

INTRODUCTION

Recently, the demand for alternatives to cow's milk increased due to health problems, different dietary preferences, concerns about hormone- and antibiotic usage in cattle, awareness about animal welfare, and also some potential environmental advantages. The most commonly used plant-based milk alternatives (PBMAs) in cake production are generally soy- and coconut-based (Fig. 1.) which aim for partially (generally 25, 50, and 75%) and/or totally replacement of cow's milk, egg, or fat (Fig. 2.).

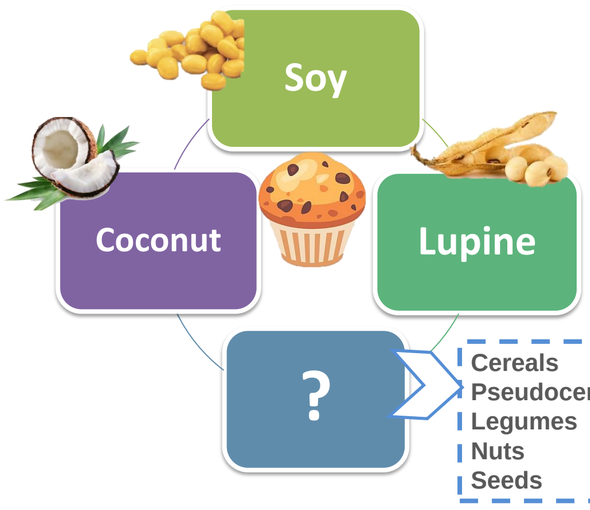

Fig 1. The major plant-based milk alternatives in cake production

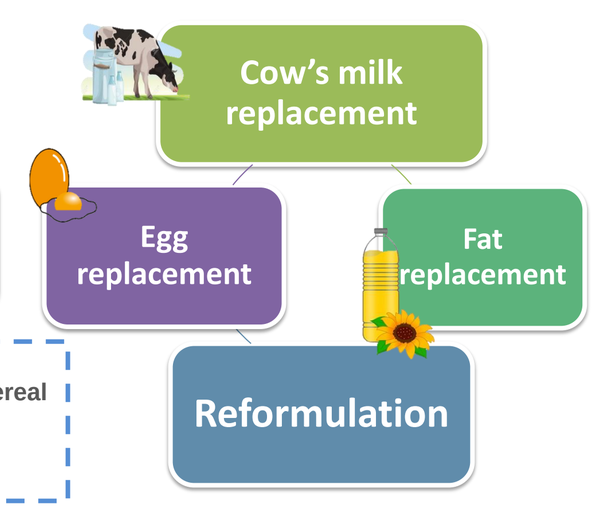

Fig 2. The major aims for using plant-based milk alternatives in cake production

Effects of plant-based milk alternatives on properties of cake batter

The viscosity showed an increase when using soy milk as a cow's milk replacer [1], and an egg replacer [2, 3]. It was explained that the high water absorption/ holding capacity of soy flour, used on purpose of soy milk production, due to its carbohydrate and protein content [3], resulted in decreasing free water availability in batter [1, 2]. The batter stability was enhanced in cakes in the case of both cows' milk and egg replaced with soy milk as the soy milk amount increased [1, 3]. This was attributed to having a higher emulsifying ability of soy milk [2], and being in charge of stabilization of the oil in water emulsion [3] (Table 1).

Table 1. The major effects of using plant-based milk alternatives on cake batter properties

Aim	Plant-based milk alternative type	Coancentration[a] or replacement ratio[b]	Batter properties	
Cow's milk replacement	Soy milk	25, 50, 75, 100 %[a]	Viscosity↑, specific gravity↓, emulsion stability↑	[1][x]
Egg replacement	Soy milk (combined with different emulsifiers)	60[b]	Viscosity↑^, batter density↑^ (except combined with SMS, SMS+lecithin), batter stability↑^	[2][y]
Egg replacement	Soy milk	25, 50, 75, 100 %[a]	Viscosity↑, density↑(except 25%), batter stability↑	[3][y]

Effects of plant-based milk alternatives on nutritional properties of cakes

From a nutritional point of view, while the protein content was increased in subject to an increase in cow's' milk replacement ratio [1], decreased depending on increase in egg-replacement ratio except 25% [4]. This state could be attributed to replacement type and thus differences in the nutritional composition of cow's milk and eggs (Table 2).

Table 2 The major effects of using plant-based milk alternatives on nutritional properties of cake

Aim	Plant-based milk alternative type	Concentration [a] or replacement ratio[b]	Nutritional properties	
Cow's milk replacement	Soy milk	25, 50, 75, 100 %[a]	Protein↑, fat↑, carbohydrate↓, ash↔(25, 50%)	[1][x]
Egg replacement	Soy milk	25, 50, 75% [a]	Protein↓^, fat↓^, ash↑^, total phenolic content↓^(except 25%), antioxidant activity↓^, mineral (Ca, K, Mg, Mn)↑^, mineral (P, Zn)↓^	[4][y]
Fat reduction	Soy milk	15-60%[d]	Fat↓	[5]
Reformulation	Fresh soy milk	15.4%[c]	Protein↑, fat↑, carbohydrate↔, ash↔, fibre↓	[6][z]
Reformulation	Fresh coconut milk	15.4%[c]	Protein↑, fat↑, carbohydrate↑, ash↔, fiber↔,	[6][z]
Egg replacement	Lupin milk	25, 50, 75%[a]	Protein↓^, fat↓^, ash↓^(except 25%), total phenolic content↓^, antioxidant activity↓^, mineral (Ca, Mn)↑^, mineral (P, Zn)↓^	[4][y]

Effects of plant-based milk alternatives on physicochemical and technological properties of cake properties

From the point of technological features, the baking loss was significantly reduced in cakes with soy milk addition due to its high water absorption/holding capacity, and thus retaining more water in the batter resulted in less water evaporation from cake surface while cooking process [1]. The specific volume of dairy-free cakes yielded an increasing tendency with soy milk amount increase, which was related to high protein content and low batter specific gravity [1]. However, a decrease tendency in egg-replaced cakes with an increase in replacement ratio on not only the volume index but also the symmetry index were observed, which was about more prominent in soy milk as regards to lupin milk [4]. The crust color values (L*, a*, b*) were higher in partially egg-replaced cakes made with lupin milk than in soy milk) [4]. An increase hardness values was associated with the soy-bean protein which coagulates throughout baking and by this means contributes to the strengthening of the crumb structure.[1]. The hardness values showed also an increase tendency with an increase in egg replacement ratio with plant-based milk alternatives, but lupin milk-based egg-replaced cakes were softer than that of soy milk-based ones [4]. The overall acceptability values were significantly decreased in both soy- and lupin-milk-based cakes at high egg replacement ratios. On the other side, scores of several sensorial properties (texture, taste, aroma, overall acceptability) were higher in fresh coconut milk-based egg-replaced cakes vis-à-vis soy milk. This was ascribed to volatile compounds such as delta-lactone, n octanol, decanoic acid, and dodecanoic acid in coconut milk giving sweet, creamy, nutty, and fresh flavor [6] (Table 3).

Table 3. The major effects of using plant-based milk alternatives on technological properties of cake

Aim	Plant-based milk alternative type	Cake properties	
Cow's milk replacement	Soy milk	Moisture↑, baking loss↓, specific volume↑, Texture: hardness↑, chewiness↑, springiness↔, cohesiveness↑, Sensory: color↔, texture↔, taste↔, aroma↔	[1][x]
Egg replacement	Soy milk	Moisture↑^, volume index↓^, symmetry index↓^, uniformity index↓^, Color(crust): L*↑^, a*↓^, b*↑^, Texture: hardness↑^, Sensory: appearance↓ (except 25%), color↓(except 25%), pore structure↓(except 25%), taste↓ (except 25%), odor↓(except 25%), overall acceptability↓(except 25%)	[4][y]
Reformulation	Fresh soy milk	Moisture↓, aw↑, pH↓, Color: L*↑, a*↔, b*↔, Texture: hardness↑, chewiness↑, cohesiveness↑, springiness↑, Sensory: appearance↑, color↑, texture↑, taste↑, overall acceptability↑	[6][z]

CONCLUSION & FUTURE WORKS

Apart from the different raw material variety and/or species, the influence optimization of process parameters particularly raw material: water ratio and thermal treaatment (i.e. temperature, time) on batter and cake properties should evaluated. Thereafter, the possibility of utilizing non-thermal food processing technologies (i.e. ultrasound, pulsed electric field, cold plasma, and gamma irra-diation) on PBMAs for developing new cake formulations at an industrial scale by using innovative techniques should also remain on the agenda. Furthermore, future studies should also aim the evaluate the influence of PBMAs on the quality of gluten-free cakes. Additionally, more studies are needed to compare the pros and cons of using different PBMAs in cake production on environmental impacts.

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