LEGUME PROTEINS: AN ALTERNATIVE SOURCE IN CAKE PRODUCTION

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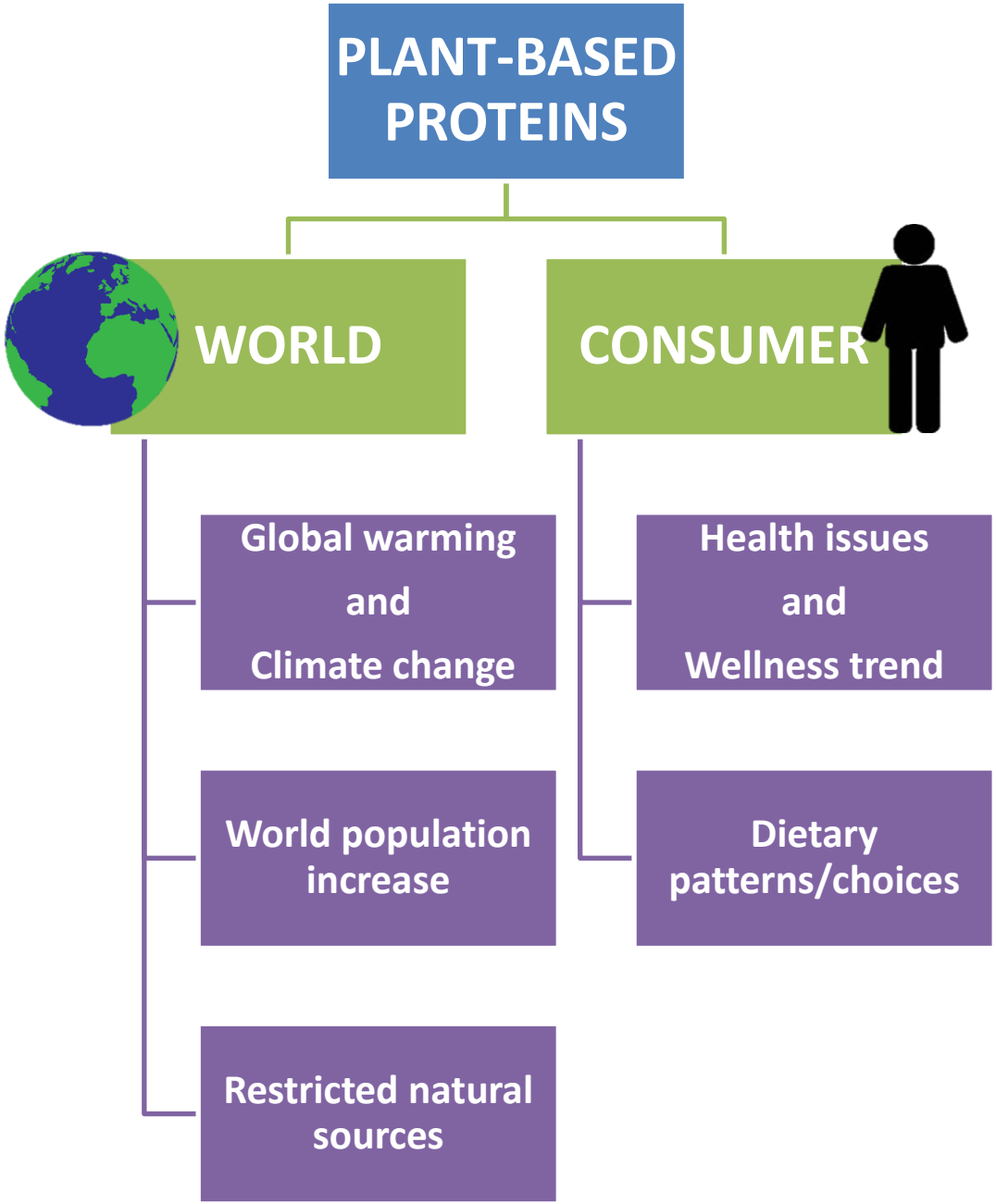

Fig 1. The reasons behind the using plant-based proteins

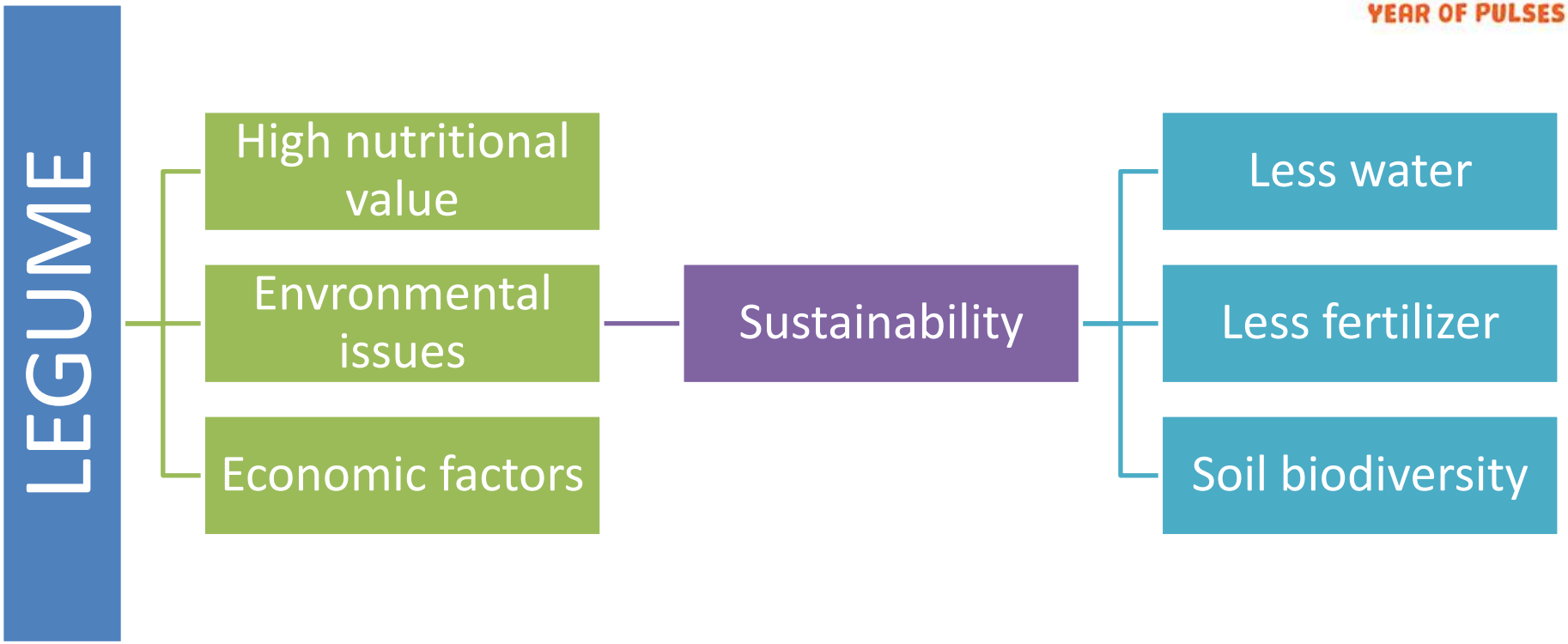

Fig 2. The reasons behind the using legume and legume-based compounds

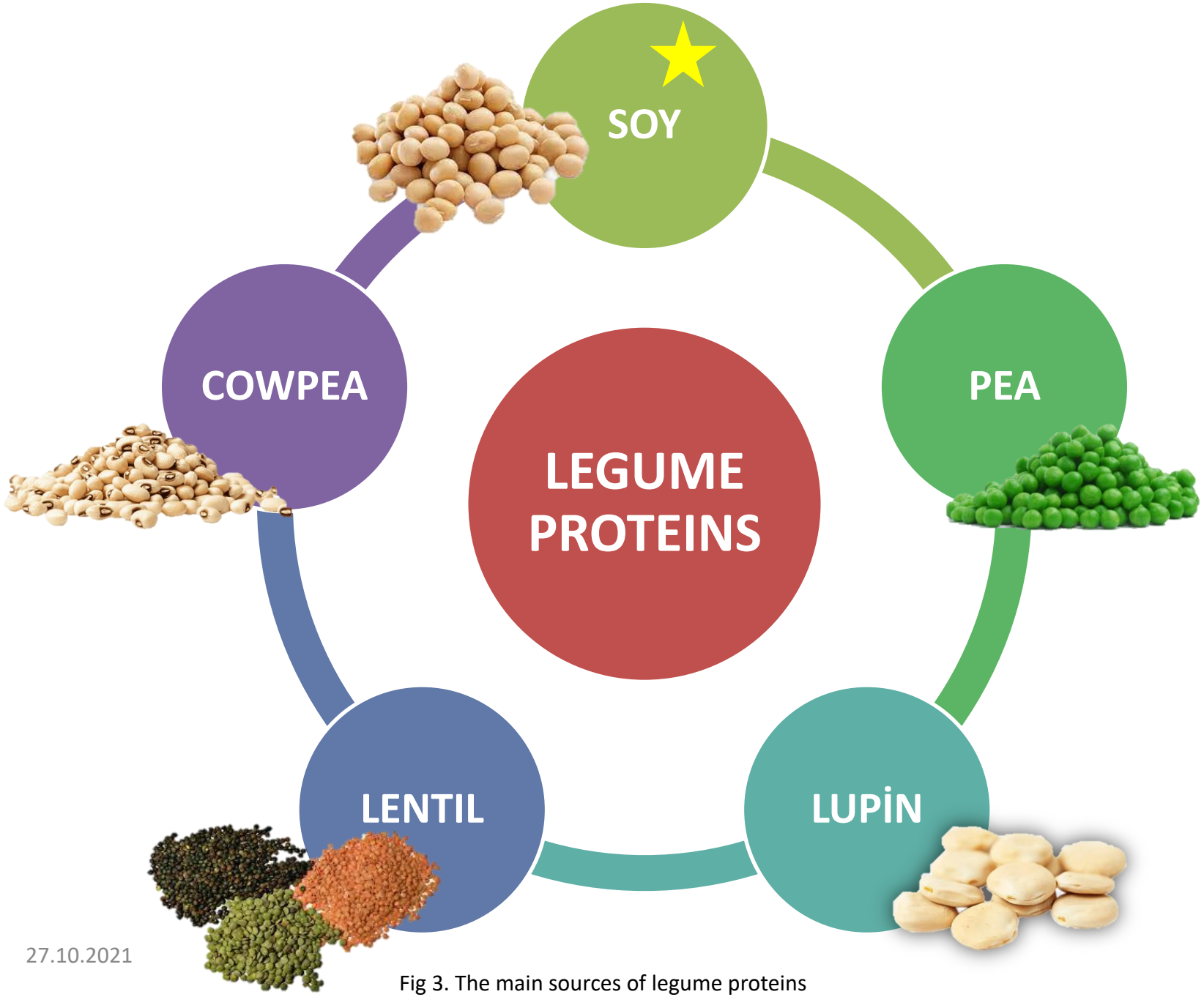

Fig 3. The main sources of legume proteins

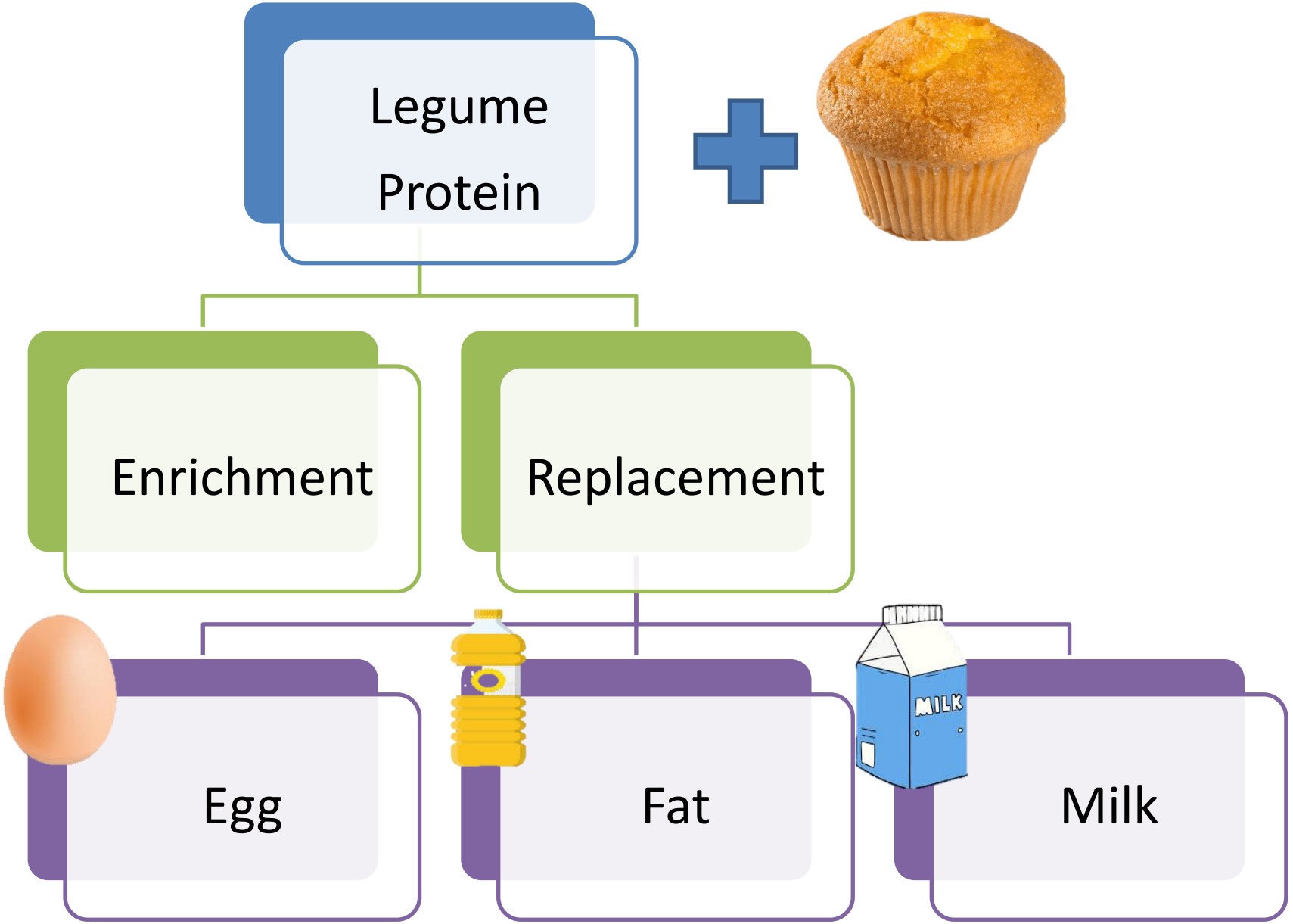

Fig 4. The reasons behind the using legume proteins in cake producing

Table 1 . The effects of using soy protein on nutritional properties of cakes

Type of Legume Protein	Aim of Using Legume Protein	Nutritional Composition			References
		↓	↑	↔	
SPI	Egg replacement	Protein, carbohydrate, ash	Fat, crude fiber		Julianti et al., 2016
SPI	Fat reduction	Fat, total energy	Protein, ash		Akesowan, 2010
SPH	Milk replacement	Starch, sugar (reducing-, non-reducing-), total caloric value, digestible carbohydrates, glycemic index, glycemic load	Total dietary fiber	Protein, fat	de Souza and Schmiele, 2021

SPH: soy protein hydrolysate, SPI: soy protein isolate

Table 2. The effects of using soy protein on quality properties of cakes

Source of Legume Protein	Type of Legume Protein	Other Ingredient (s)	Product	Aim of Using Legume Protein	Cake Properties			References
					↓	↑	↔	
SOY	SPC	___	Sponge cake	Enrichment	Specific volume, volume index, Color (crust):a (except 3 and 9%)	Weight, symmetry index (>9%), Color (crust): L (except 3 and 9%), Texture: hardness (except 3%), chewiness (except 3 and 6%)	Uniformity index, Color (crust): b, Texture: springiness (except 9 and 21%), cohesiveness	Sung et al., 2006
	SPI	___	Fermented rice cake	Enrichment	Specific volume, cell density (except 0.5%), Color (crust): L*, a*	Color (crust): b*	Porosity ratio (except 1%), Texture: hardness	Meng and Kim, 2020
	SPI	Konjac gum, guar gum	Sugar-free muffin	Fat replacement	Moisture, specific volume, Color (crumb): a*, b*, Texture: springiness	Color (crumb): L*, Texture: hardness, cohesiveness	Porosity,* homogeneity*	Azmoon et al., 2021
	SPI	Konjac flour	Chiffon cake	Fat reduction	Specific volume, Color: L*, Texture: hardness, cohesiveness, springiness, chewiness, Sensory: flavor	Moisture, aw, weight loss, Color: a*, Sensory: sweetness, juiciness		Akesowan, 2010

*Results were given for the optimum cake formulation, SPC: soy protein concentrate, SPI: soy protein isolate

Table 2 *(continued)*. The effects of using soy protein on quality properties of cakes

Source of Legume Protein	Type of Legume Protein	Other Ingredient (s)	Product	Aim of Using Legume Protein	Cake Properties			References
					↓	↑	↔	
SOY	SPI	XN, Emulsifier (MDG, soy lecithin)	Yellow cake	Egg replacement	Moisture, specific volume Color: L*, b*, Texture: springiness, Sensory: overall aroma	Texture: firmness, Color: a*	Sensory: overall appearance	Lin et al., 2017b
	SPI	XN	Gluten-free muffin	Egg replacement	Height, Color (crumb): L*, Texture: resilience	Color (crumb) a*, b*, Texture: hardness	Specific volume, weight loss, Texture: springiness, chewiness	Matos et al., 2014
	SPI	XN	Gluten-free cake	Egg replacement	Color: browning index		Moisture, specific volume, Texture: firmness	Julianti et al., 2016
	SPI	___	Sponge cake	Egg replacement	Density (except 5%), Color (crust): L (except 5%), b (except 5%), Texture: cohesiveness, springiness, chewiness	Height, volume (except 5%), Color (crust): a, Texture: hardness		Majzoobi et al., 2014
	SPH	HPMC Emulsifier	Low Carb Cake	Milk replacement	Symmetry index, Color: L*, b*, average cell size, Sensory: aroma, taste, acceptability index	Texture: firmness, Color: a*		de Souza and Schmiele, 2021

HPMC: hydroxypropyl methylcellulose, MDG: mono- and diglycerides; SPH: soy protein hydrolysate, SPI: soy protein isolate; XN: xanthan gum

Table 3. The effects of using pea protein on quality properties of cakes

Source of Legume Protein	Type of Legume Protein	Other Ingredient (s)	Product	Aim of using Legume Protein	Cake Properties			References
					↓	↑	↔	
PEA	PP	___	Gluten-free layer cake	Enrichment	Volume, Texture: cohesiveness, Sensory: appearance, taste, overall acceptability			Bravo- Núñez et al., 2020
	PP	___	Gluten-free layer cake	Enrichment	Specific volume (except 15%), weight loss (except 15%), Color (crust): L*, b*, Texture: springiness, cohesiveness, Sensory^: appearance, odor, taste, overall acceptability	Color (crust): a*, Texture: hardness (except 15%)		Sahagún et al., 2018
	PPI	XN, Emulsifier (MDG, soy lecithin)	Yellow cake	Egg replacement	Moisture, specific volume, Color: L*, Texture: springiness, average pore size	Color: a*, Texture: Firmness	Color: b*	Lin et al., 2017b
	PPI	XN	Gluten-free muffin	Egg replacement	Height, Color (crumb): L*,	Color (crumb): a*, b*, Texture: springiness, cohesiveness	Weight loss, specific volume, Texture: hardness, chewiness, resilience	Matos et al., 2014
	PPC	Soy lecithin	Eggless cake	Egg replacement	Cell/cm^2	Bulk density, Height:weight ratio, Texture: firmness	Color: yellowness	Shah et al., 2019

^Results were given for the cakes including 30% PP; PP: pea protein (78.13% protein); PPC: pea protein concentrate; PPI: pea protein isolate

Table 4. The effects of using some other legume proteins on quality properties of cakes

Source of Legume Protein	Type of Legume Protein	Other Ingredient (s)	Product	Aim of using Legume Protein	Cake Properties			References
					↓	↑	↔	
OTHERS	LEPC	___	Angel cake Muffin	Egg/milk replacement	Moisture (angel cake), baking loss (angel cake, muffin), mean area of air cell (muffin)	Number of air cells per mm^2 (angel cake, muffin)	Moisture (muffin), Height (angel cake, muffin), Color (crumb): L* (angel cake, muffin), mean area of air cell (angel cake), Sensory: flavor (angel cake, muffin)	Jarpa-Parra et al., 2017
	CPI	MDG	Sponge cake	Egg replacement	Volume (7.2%), Texture: firmness (7.2%), Sensory: overall acceptability		Volume (3.5%), Texture: firmness (3.5%),	Campbell et al., 2016
	LUPI	XN, Emulsifier (MDG, soy lecithin)	Yellow cake	Egg replacement	Moisture, volume, height	Texture: hardness		Arozarena et al., 2001*

*Results were given for the optimum cake formulation; CPI: cowpea protein isolate; LEPC: Lentil protein concentrate; LUPI: lupine protein isolate; MDG: mono- and diglycerides

CONCLUSION

Further studies should more center upon using other legumes like lentil and lupin and optimization to get more efficent and economical extracts, because there is a remarkable amount of consumers who have soy allergy. Beside, the following studies not only focus on the influence of using different legume proteins for enrichment or replacement on the technological properties of batter and cakes but also the nutritional value of the end-product. In this regard, these kinds of cakes should be assessed in terms of not only proximate composition but also their protein quality.

THANK YOU FOR YOUR ATTENTION

REFERENCES

- Abu-Ghoush, M., Herald, T. H. J., & Aramouni, F. M. (2010). Comparative study of egg white protein and egg alternatives used in an angel food cake system. *Journal of Food Processing and Preservation*, *34*, 411–425. https://doi.org/10.1111/j.1745-4549.2008.00284.x
- Agarwal, A. (2017). Proteins in Pulses. *Journal of Nutritional Disorders & Therapy*, *07*(01), 2161. https://doi.org/10.4172/2161-0509.1000e129
- Akesowan, A. (2010). Effect of konjac flour incorporated with soy protein isolate on quality characteristics of reduced-fat chiffon cakes. *African Journal of Biotechnology*, *9*(28), 4386-4391.
- Arozarena, I., Bertholo, H., Empis, J., Bunger, A., & de Sousa, I. (2001). Study of the total replacement of egg by white lupine protein, emulsifiers and Xanthan gum in yellow cakes. *European Food Research and Technology*, *213*(4–5), 312–316. https://doi.org/10.1007/s002170100391
- Assad Bustillos, M., Jonchère, C., Garnier, C., Réguerre, A. L., & Della Valle, G. (2020). Rheological and microstructural characterization of batters and sponge cakes fortified with pea proteins. *Food Hydrocolloids*, *101*, 105553. https://doi.org/10.1016/j.foodhyd.2019.105553
- Azmoon, E., Saberi, F., Kouhsari, F., Akbari, M., Kieliszek, M., & Vakilinezam, A. (2021). The effects of hydrocolloids-protein mixture as a fat replacer on physicochemical characteristics of sugar-free muffin cake: Modeling and optimization. *Foods*, *10*(7). https://doi.org/10.3390/foods10071549
- Bildstein, M., Lohmann, M., Hennigs, C., Krause, A., & Hilz, H. (2008). An enzyme-based extraction process for the purification and enrichment of vegetable proteins to be applied in bakery products. *European Food Research and Technology*, *228*(2), 177–186. https://doi.org/10.1007/s00217-008-0921-z
- Boukid, F., Zannini, E., Carini, E., & Vittadini, E. (2019). Pulses for bread fortification: A necessity or a choice? *Trends in Food Science and Technology*, *88*, 416–428. https://doi.org/10.1016/j.tifs.2019.04.007
- Bravo-Núñez, Á., Sahagún, M., Bravo-Núñez, A., & Gómez, M. (2020). Optimisation of protein-enriched gluten-free layer cakes using a mixture design. *International Journal of Food Science and Technology*, *55*(5), 2171–2178. https://doi.org/10.1111/ijfs.14470
- Campbell, L., Euston, S. R., & Ahmed, M. A. (2016). Effect of addition of thermally modified cowpea protein on sensory acceptability and textural properties of wheat bread and sponge cake. *Food Chemistry*, *194*, 1230–1237. https://doi.org/10.1016/j.foodchem.2015.09.002
- de Souza, A. R., & Schmiele, M. (2021). Custard apple puree, fructooligosaccharide and soy protein hydrolysate as alternative ingredients in low carb pound cake. *Journal of Food Science and Technology*, *58*(9), 3632–3644. https://doi.org/10.1007/s13197-021-05155-9
- Gravel, A., & Doyen, A. (2020). The use of edible insect proteins in food: Challenges and issues related to their functional properties. *Innovative Food Science and Emerging Technologies*, *59*, 102272. https://doi.org/10.1016/j.ifset.2019.102272
- Jarpa-Parra, M., Wong, L., Wismer, W., Temelli, F., Han, J., Huang, W., Eckhart, E., Tian, Z., Shi, K., Sun, T., & Chen, L. (2017). Quality characteristics of angel food cake and muffin using lentil protein as egg/milk replacer. *International Journal of Food Science and Technology*, *52*(7), 1604–1613. https://doi.org/10.1111/ijfs.13433

REFERENCES

- Julianti, E., Rusmarilin, H., Ridwansyah, & Yusraini, E. (2016). Effect of gluten free composite flour and egg replacer on physicochemical and sensory properties of cakes. *International Food Research Journal*, *23*(6), 2413–2418.
- Lin, M., Tay, S. H., Yang, H., Yang, B., & Li, H. (2017a). Development of eggless cakes suitable for lacto-vegetarians using isolated pea proteins. *Food Hydrocolloids*, *69*, 440–449. https://doi.org/10.1016/j.foodhyd.2017.03.014
- Lin, M., Tay, S. H., Yang, H., Yang, B., & Li, H. (2017b). Replacement of eggs with soybean protein isolates and polysaccharides to prepare yellow cakes suitable for vegetarians. *Food Chemistry*, *229*, 663–673. https://doi.org/10.1016/j.foodchem.2017.02.132
- Majzoobi, M., Ghiasi, F., Habibi, M., Hedayati, S., & Farahnaky, A. (2014). Influence of soy protein isolate on the quality of batter and sponge cake. *Journal of Food Processing and Preservation*, *38*(3), 1164–1170. https://doi.org/10.1111/jfpp.12076
- Matos, M. E., Sanz, T., & Rosell, C. M. (2014). Establishing the function of proteins on the rheological and quality properties of rice based gluten free muffins. *Food Hydrocolloids*, *35*, 150–158. https://doi.org/10.1016/j.foodhyd.2013.05.007
- Meng, L. W., & Kim, S. M. (2020). Effects of different proteins on the rheological properties of rice batter and characteristics of fermented rice cakes. *Journal of Food Processing and Preservation*, *44*(11), 1–11. https://doi.org/10.1111/jfpp.14857
- Ronda, F., Oliete, B., Gómez, M., Caballero, P. A., & Pando, V. (2011). Rheological study of layer cake batters made with soybean protein isolate and different starch sources. *Journal of Food Engineering*, *102*(3), 272–277. https://doi.org/10.1016/j.jfoodeng.2010.09.001
- Sahagún, M., Bravo-Núñez, Á., Báscones, G., & Gómez, M. (2018). Influence of protein source on the characteristics of gluten-free layer cakes. *Lwt*, *94*, 50–56. https://doi.org/10.1016/j.lwt.2018.04.014
- Shah, N. N., K.V., U., & Singhal, R. S. (2019). Hydrophobically modified pea proteins: Synthesis, characterization and evaluation as emulsifiers in eggless cake. *Journal of Food Engineering*, *255*, 15–23. https://doi.org/10.1016/j.jfoodeng.2019.03.005
- Sung, M., Park, Y., & Chang, H. (2006). Quality Characteristics of sponge cake supplemented with soy protein concentrate. *Food Science and Biotechnology*, *15*(6), 860-865.
- Yazici, G. N., & Ozer, M. S. (2021). A review of egg replacement in cake production: Effects on batter and cake properties. *Trends in Food Science and Technology*, *111*, 346–359. https://doi.org/10.1016/j.tifs.2021.02.071