Aquafaba: A Functional Ingredient for Food Products

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Introduction

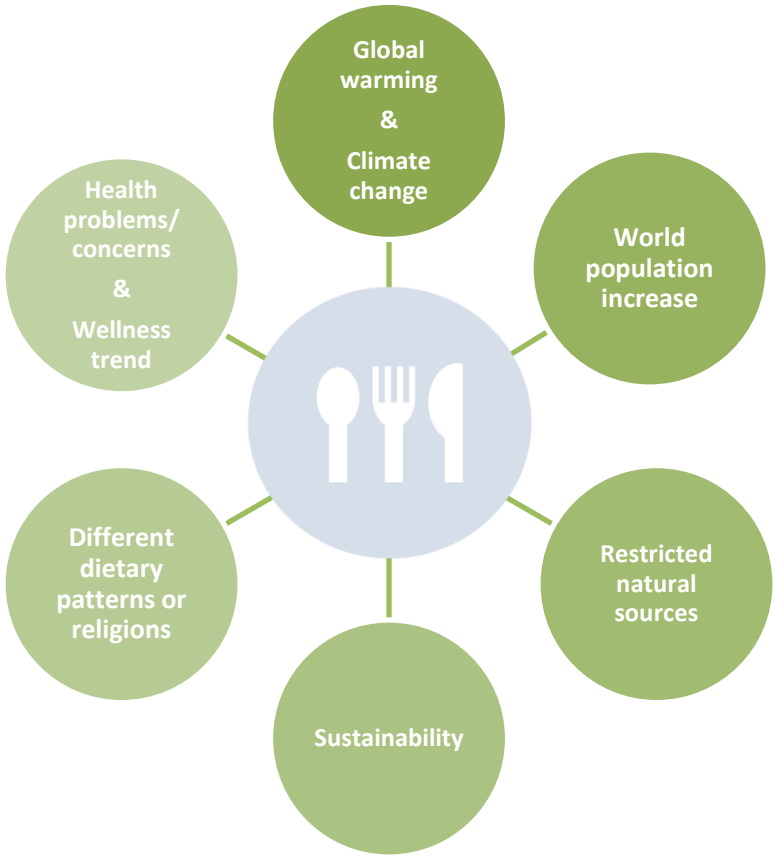

Fig 1.The reasons behind the seeking of alternative food/protein sources

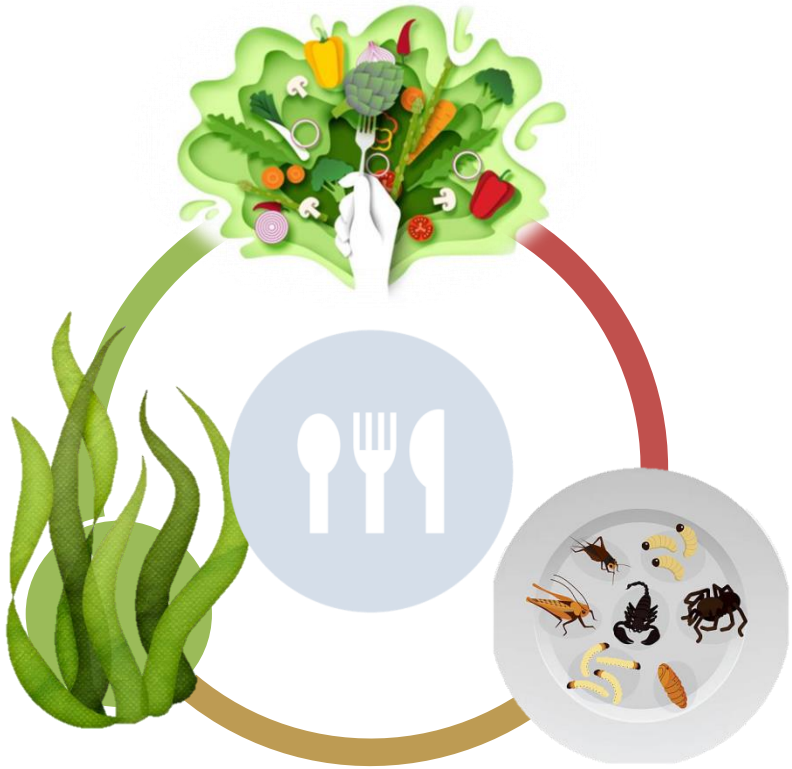

Fig 2. The alternative and sustainable food /protein sources

‘Aquafaba’ term

Fig 3. The origin and explanation of ‘aquafaba’.

Aquafaba production

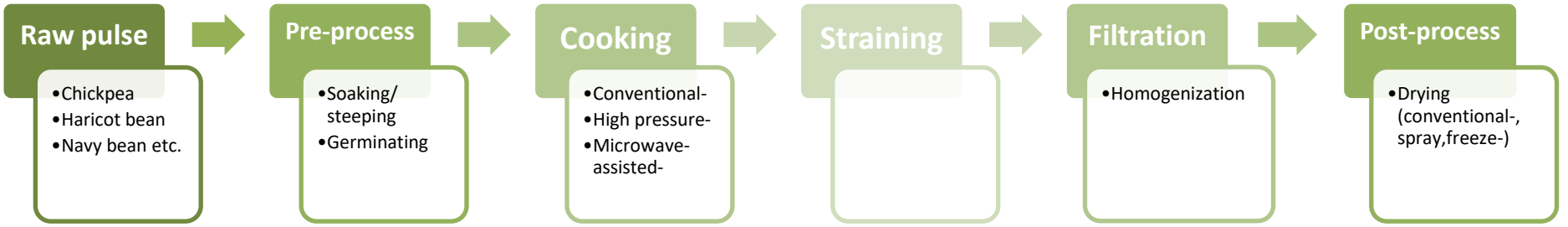

Fig 4. The general production process of aquafaba

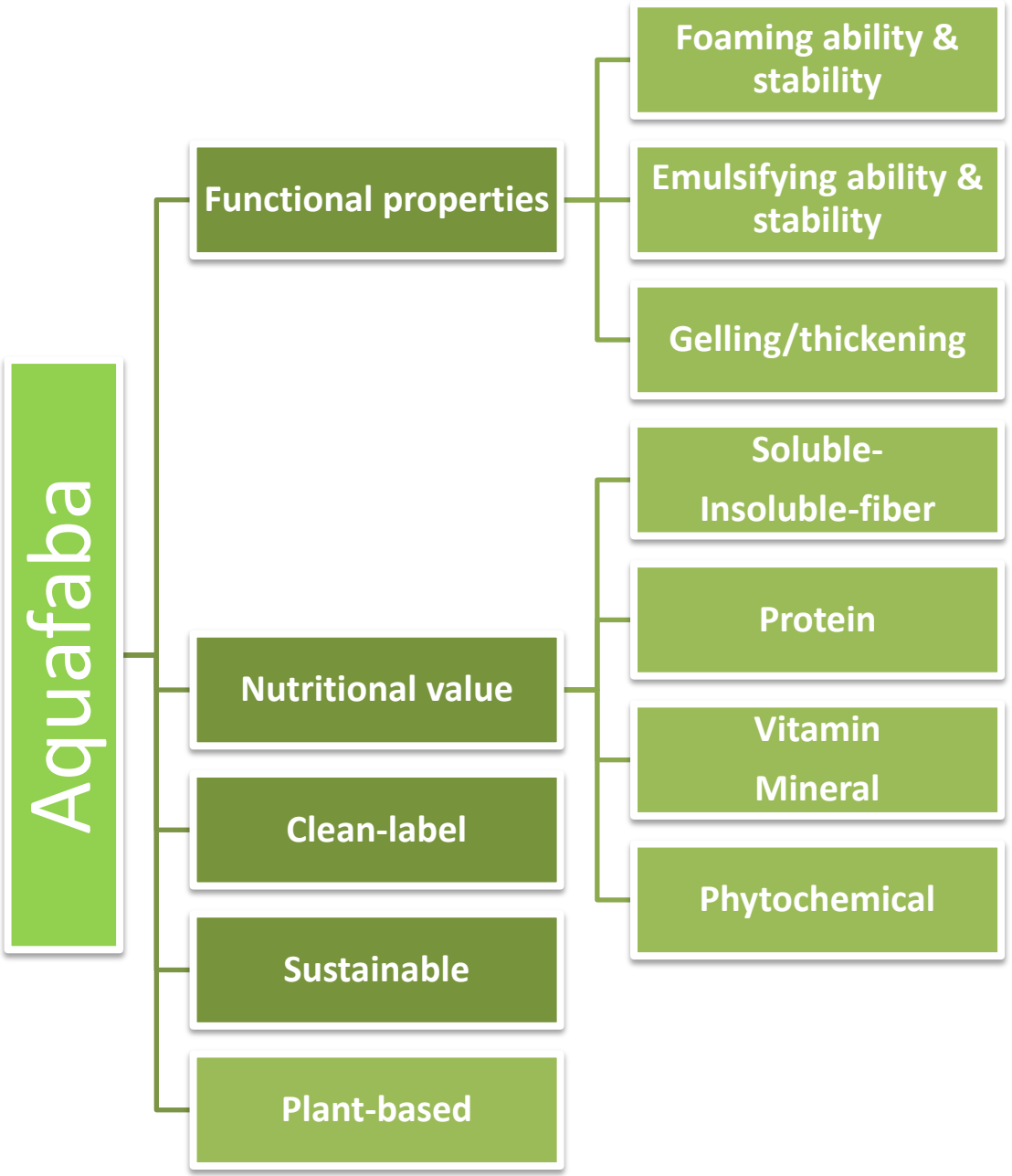

Fig 5. The advantages of using aquafaba in food products

Role of aquafaba in food products

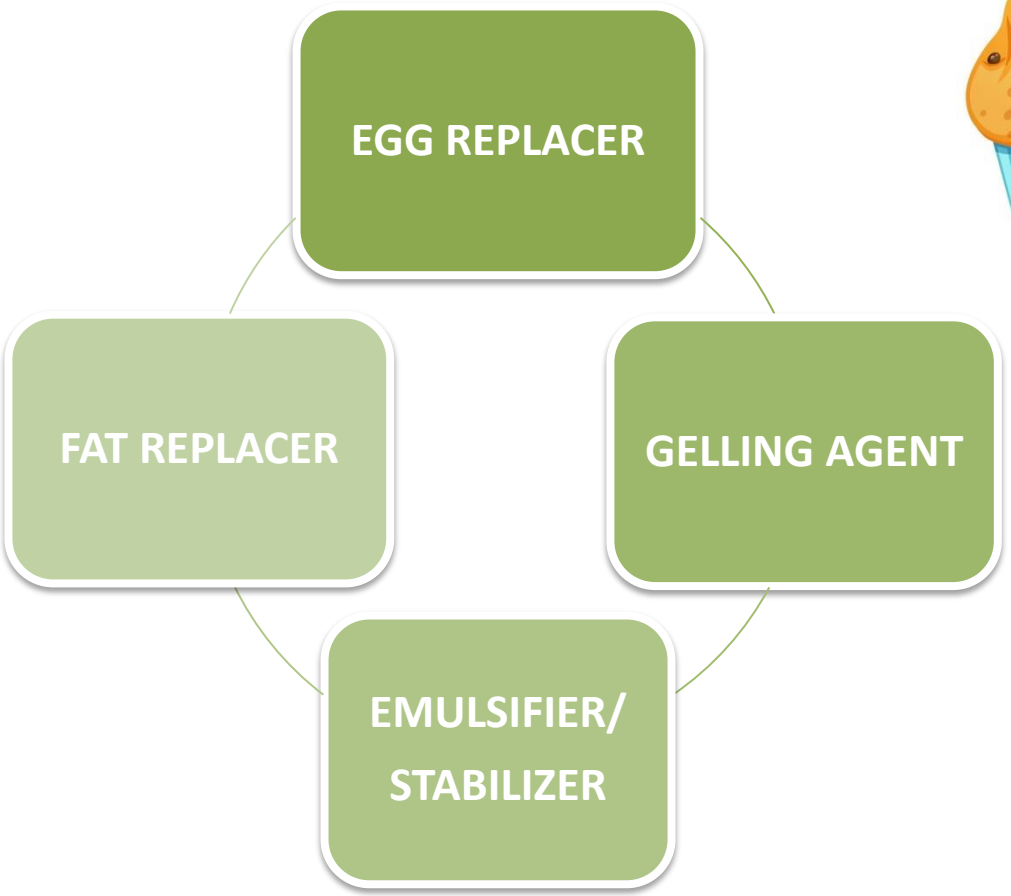

Fig 6. The role of aquafaba and associated with food products

Table 1. The aquafaba sources, their role and major findings in bakery products

End product	Aquafaba source(s)	Role of aquafaba	Major findings	References
BAKERY PRODUCTS: Cake	Chickpea (Commercially canned)	Egg white replacer	Moisture↓, pH↓^, Baking loss↑^, Height↓, Volume index↓, color(crust): L*↓, a*↑, b*↑^, Texture(crumb): hardness↓^, chewiness↓, springiness↓, cohesiveness↓, resilience↓^	Mustafa et al., 2018
	Chickpea	Egg replacer	**Batter:** pH↓, Specific gravity↓ **Cake:** Volume index↓, Symmetry index↓, Baking loss↔, color(crumb): L*↑, a*↓, b*↓, Texture: firmness↑	Aslan and Ertaş, 2020
	Lima bean	Egg replacer	Specific volume↔, Baking loss↓, color(crust):L*↓, a*↔, b*↓, Texture: hardness↓, chewiness,↓, springiness↓, cohesiveness↓	Nguyen et al., 2020
Gluten-free bread	Chickpea	Hydrocolloid alternative for texture improvement	**Dough:** Peak viscosity↔, Breakdown↔, Final viscosity↔, Setback↓, Peak time↑ **Bread:** Moisture↔, Baking loss↔, Height↔, Specific volume↔, color: L*↔ a*↑, b*↓, Texture: hardness↓	Bird et al., 2017
	Haricot beans Garbanzo chickpeas Whole green lentils Split yellow peas Yellow soybeans	Emulsifier	**Dough:** Peak viscosity↔, Breakdown↔(except yellow soybean), Final viscosity↔, Setback↑(except haricot beans, whole green lentils), Peak time↔(except yellow soybean) **Bread:** Moisture↔, Specific volume↑, color: L*↓(except split yellow peas), b*(except garbanzo chickpea, split yellow peas), Texture: hardness↑(except garbanzo chickpea, split yellow peas), chewiness↓, springiness↔, cohesiveness↓	Huang et al., 2018*
Gluten-free cracker	Yellow soybeans	Emulsifier	Moisture (0.day)↓, Moisture (2.day)↑, color: L*↔, b*↑, Texture: hardness (0.day)↔, hardness (2.day)↓	Serventi et al., 2018

^ Results were not given statistically

Table 2. The aquafaba sources, their role and major findings in confectionery/dessert food products

	End product	Aquafaba source(s)	Role of aquafaba	Major findings	References
CONFECTIONERY/DESSERT	Meringue	Chickpea	Egg replacer	Color: L*↓, Texture: hardness↓, consistency↓, adhesiveness↓	Meurer et al., 2020
		Haricot beans Garbanzo chickpeas Whole green lentils Split yellow peas	Egg white replacer	Moisture↓, Height↔(except haricot beans), Specific volume↑(except haricot beans), color: L*↔, a*↔(haricot beans, split yellow peas), b*↔(haricot beans, split yellow peas), Texture: hardness↔(garbanzo chicpea, whole green lentils); hardness↑(haricot beans, split yellow peas), extensibility↓, Sensory: appearance↓(except split yellow peas), taste↓(except split yellow peas), texture↓ (except split yellow peas), overall preference↔	Stantiall et al., 2018
		Chickpea	Egg white replacer	Color: L*↔, b*↔, Sensory^: flavor↓, texture↑, overall acceptance↓, acceptability index↓	Lafarga et al., 2019
	Mousse	Garbanzo chickpeas Split yellow peas	Egg white replacer	Sensory: color↔, glossiness↔, aroma↔, sweetness↔, smoothness↔, flavor↑, overall preference↑	Damian et al., 2018
	Macaron	Chickpea (Commercially canned)	Egg white replacer	Height increase↓^, Width,↓^, Yield↓^, Sensory^ (just for regarding 5 score): taste↓, texture↓, appearance↓	Horner, 2019

^ Results were not given statistically

Table 3. The aquafaba sources, their role and major findings in some other food products

End product		Aquafaba source(s)	Role of aquafaba	Major findings	References
OTHER FOOD PRODUCTS	Mayonnaise	Chickpea (Commercially canned)	Egg replacer Fat replacer	Color: L*(0.day and 28.day)↔, a*(0.day and 28.day), b*↓^(0.day and 28.day), Texture: firmness↓, adhesive force↓, adhesiveness↓, cohesiveness↔	Raikos et al., 2019[x]
		Chickpea	Egg white replacer	Color: L*↓, a*↔, b*↑, Sensory*: flavor↓, texture↓, overall acceptance↓, acceptability index↓	Lafarga et al., 2019
		Chickpea	Egg replacer	pH↔, Brix↑^, Viscosity↑^, Texture: firmness↑, consistency↑, cohesiveness↔, Sensory: appearance↑, color↑, aroma↔, taste↔, Bacteial load↓^	Muhialdin et al., 2021[y]
		Chickpea	Egg replacer Emulsifier	pH↓, Emulsion stability↓, Heating stability(freeze-dried)↑, Heating stability(spray-dried)↔, color: L*↓, b*↓	He et al., 2021b[z]
	Non-dairy yoghurt	ND	Gelling agent	pH↑, Titrable acidity↑, WHC↑, Syneresis↓, Texture: hardness↑, adhesiveness↑, gumminess↑, chewiness↑^, Viable counts of *S. thermophillus* and *L. bulgaricus*↑	Raikos et al., 2020
	Non-dairy ice-cream	Chickpea Split yellow pea	Emulsifier	Color: L*↔, a*↑(chickpea), a*↔(split yellow pea), b*↑(chickpea), b*↔(split yellow pea), Texture: hardness↑^, Sensory: color↔, creaminess↔, sweetness↔, overall acceptability↓(chickpea), overall acceptability↔(split yellow pea)	Serventi et al., 2020b*
	Whipped cream	Chickpea	Egg white replacer	Average diameter↑, Texture: hardness↓, adhesiveness↔, cohesiveness↑, springiness↑, gumminess↓, chewiness↑	Minh Nguyet et al., 2021

WHC: water holding capacity, ^ Results were not given statistically, [x]Results were compared according to increase in fat replacement ratio, [y]Results were compared according to increase in soaking time, [z]Results were given for 28.day of storage

Aquafaba-based Food Market

Conclusion

- New era for researchers and food manufacturers because of its nutritional and functional properties,
- Gives an opportunity to reduce environmental load, by recycling by-products into value-added food ingredients,
- Promising clean-label and eco-friendly ingredient for sustainable food production and a circular economy,
- Restrictions on the quality standardization of aquafaba and applied food products for industrialization and commercialization,
- Needed for the optimization of different drying methods and process parameters are important for industrialization,
- More aquafaba-applied food products and effects on the quality of end-products, even regarding gluten-free and non-dairy food products.

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