Analysis of cooking quality, nutritional and organoleptic characteristics of pasta enriched with fresh and dried microbial biomass

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Fresh biomass rather than dried in food products?

INTRODUCTION

There are environmental, resources efficiency and biodiversity reasons to reduce the consumption of animal proteins, alternatives are therefore required. Besides plant-based alternatives, microbial biomass such as spirulina (*Arthrospira platensis*) appears promising. Indeed, from a nutritional point of view, its high protein content and diversity together with high levels of vitamins, minerals and antioxidants makes it an attractive food.

Food products enriched with dried spirulina have been studied but formulations include low percentages of biomass and show low acceptance as dried spirulina present off-flavours and unpleasant odours. In this study, the use of fresh spirulina and the comparison between the two forms of biomass are explored.

Fresh pasta was chosen as an appropriate model due to its popularity and the simplicity of its formulation and its high water content.

The aim of this study was to analyse the physico-chemical, nutritional and organoleptic effects between fresh and dried spirulina biomass in pasta-type formulations.

METHODS

Ingredients and formulations

Biomass *Arthrospira platensis* was supplied by Etika Spirulina (France): fresh form is stored frozen at -18°C after harvesting and dried form (powder) is processed at a temperature below 42°C under filtered air.

Dry matter content in pasta dough is fixed at 33%. The 2 parameters that vary are the form of biomass used (fresh or dried) and the quantity incorporated.

Figure 1 : Dried (left) and fresh biomass (right)

		Formulation 2%		Formulation 6%		Formulation 10%		Control 0%
		Fresh	Dried	Fresh	Dried	Fresh	Dried	
Water		27%	33%	13%	33%	0%	33%	33%
Flour type 00		64%	64%	60%	60%	55%	55%	66%
Salt		1%	1%	1%	1%	1%	1%	1%
Biomass	**Dry matter provided by biomass**	2%	2%	6%	6%	10%	10%	0%
	Water supplied by biomass	7%	0%	20%	0%	33%	0%	0%
Total proportion of biomass		9%	2%	26%	6%	44%	10%	0%

Table 1 : Proportions of ingredients in three pasta formulations

Pasta analyses

Analyses performed to assess the impact of the biomass **form** and **quantity** of biomass used:

- Colour (ColorFlex EZ spectrophotometer) on cooking water and on raw and cooked pasta
- Water activity (Aqualab® Decagon CX3) of raw pasta
- Firmness and chewiness of cooked pasta (TA.XTPlus texturometer)
- Calculated nutritional value (Youmeal logical)
- Cooking quality parameters :

$$\textbf{Cooking Loss}\ (\%) = \frac{Weight\ of\ cooking\ water\ residue}{Weight\ of\ uncooked\ pasta} \times 100$$

$$\textbf{Swelling Index} = \frac{Cooked\ pasta\ weight\ - Cooked\ pasta\ weight\ after\ drying}{Cooked\ pasta\ weight\ after\ drying}$$

$$\textbf{Weight Increase}\ (\%) = \frac{Weight\ increase\ of\ cooked\ pasta\ - Weight\ of\ uncooked\ pasta}{Weight\ of\ uncooked\ pasta} \times 100$$

RESULTS

Colour

Figure 2 : Colour and appearance of different pasta formulations
a - Control, b - dried 2%, c - fresh 2%, d - fresh 10%

	L *Lightness*		a *Greeness*		b *Yellowness*	
Biomass quantity	**Dried**	**Fresh**	**Dried**	**Fresh**	**Dried**	**Fresh**
0%	12.13 ± 0.89^{d}		-1.02 ± 0.07^{d}		-2.48 ± 0.22^{d}	
2%	11.99 ± 0.66^{ax}	13.68 ± 0.46^{ay}	-2.04 ± 0.23^{ax}	-3.12 ± 0.5^{ay}	-1.79 ± 0.81^{ax}	3.58 ± 1.87^{ay}
6%	11.62 ± 0,48^{ax}	14.14 ± 1.19^{ay}	-3.24 ± 0.27^{bx}	-4,23 ± 0,26^{by}	-1.28 ± 1.05^{ax}	9.08 ± 2.29^{by}
10%	16.24 ± 0.71^{bx}	14.25 ± 1.49^{ay}	-4.53 ± 0.3^{cx}	-4.05 ± 0.08^{by}	-0.03 ± 0.71^{bx}	8.1 ± 3.23^{by}

Table 2: Colour measurements of cooking water

Values are expressed as mean ± standard deviation, n = 9.
a-c Values in the same column followed by different letters indicate significant differences / x-y Values in the same row followed by different letters indicate significant differences of the parameter with respect to parameters L, a or b

- Fresh biomass colours significantly more water than dried biomass

Water activity

To assess food preservation, water activity of fresh raw pasta should be between 0.92 and 0.97. The results showed a water activity between 0.93 and 0.95 for all formulations.

Quality parameters

Quality Characteristics	Control 0%	Formulation 2%		Formulation 6%		Formulation 10%	
		Dried	Fresh	Dried	Fresh	Dried	Fresh
Weight increase (%)	53.29 ± 2.15^{a}	51.42 ± 1.3^{b}	65.76 ± 5.32^{c}	48.64 ± 1.14^{b}	63.99 ± 1.77^{c}	50.41 ± 1.14^{b}	65.93 ± 5.56^{c}
Swelling Index (g/g dry matter)	1.45 ± 0.02^{a}	1.4 ± 0.05^{a}	1.46 ± 0.04^{a}	1.33 ± 0.04^{b}	1.53 ± 0.04^{c}	1.35 ± 0.03^{b}	1.59 ± 0.07^{c}
Cooking losses (%)		2.77 ± 0.19^{b}	2.92 ± 0.63^{b}	2.78 ± 0.09^{b}	4.08 ± 0.37^{a}	2.89 ± 0.22^{b}	5.02 ± 0.7^{a}

Table 3: Quality parameters of the different pasta formulations
Values are expressed as mean and standard deviation, n = 9. Means followed by different letters are significantly different

- Fresh biomass leads to an increase in pasta weight but does not increase proportionally to the amount of biomass incorporated.
- Instead, cooking losses increase with the proportion of fresh biomass incorporated.
- Quality parameters increase when fresh biomass is incorporated into formulations. With dried biomass, the parameters are more stable.

Texture

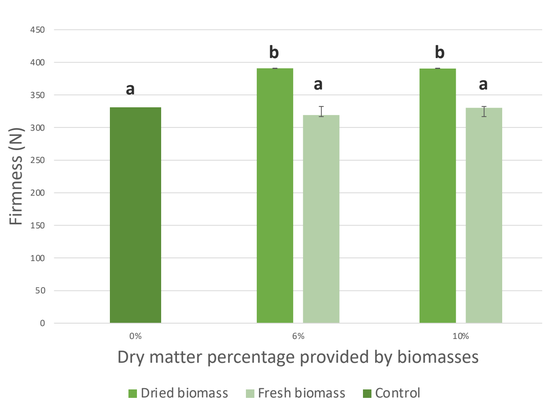

Figure 3: Pasta's firmness of the formulations
Different letters indicate significant differences

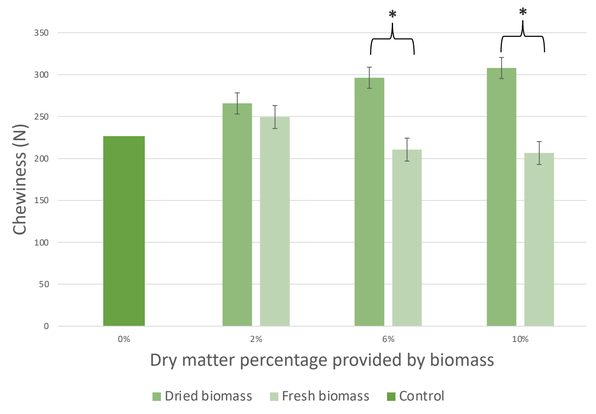

Figure 4: Pasta's chewiness of the formulations
** indicate significantly different*

- Dried biomass increases firmness, while fresh biomass has no effect on it.
- Chewiness of control pasta is comparable to fresh biomass pasta and significantly different to dried biomass pasta.

CONCLUSION AND PERSPECTIVES

- While control pasta provides 7g of protein/100g, pasta from "Formulation 10% **Fresh**" provides 14g of protein/100g. **By incorporating fresh biomass, the protein content of pasta can be multiplied by two.** According to tests and literature, dried biomass cannot provide these results because consumers will not accept high proportions of dried biomass due to its fishy taste.
- The use of biomass, fresh or dried, demonstrated positive results for **water activity** measurements. In terms of **texture**, fresh biomass did not influence the firmness or chewiness of the pasta, unlike dried biomass.
- Fresh biomass colours significantly more the water than dried and leads to **higher cooking losses**. We need to assess what is lost in the cooking water and carry out a sensorial test to determine the potential negative effect on the consumer.

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