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DURUM WHEAT PASTA ENRICHED WITH ENCAPSULATED CARROT WASTE EXTRACT

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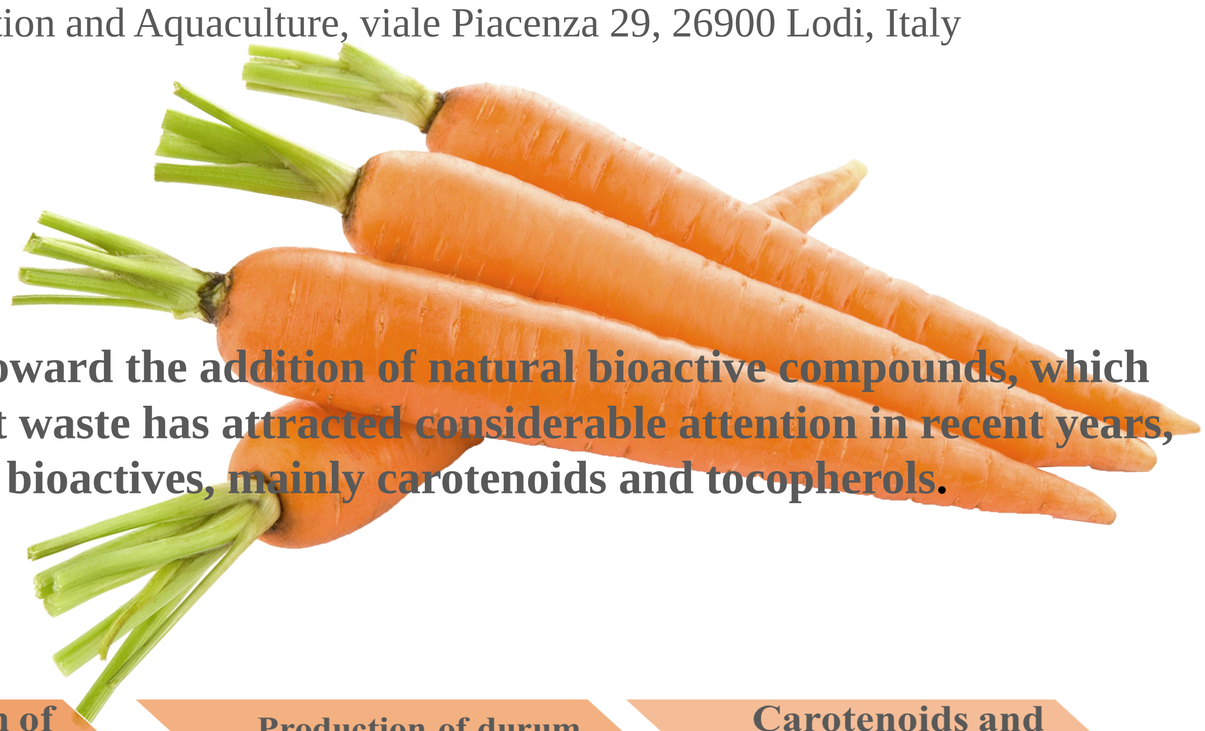
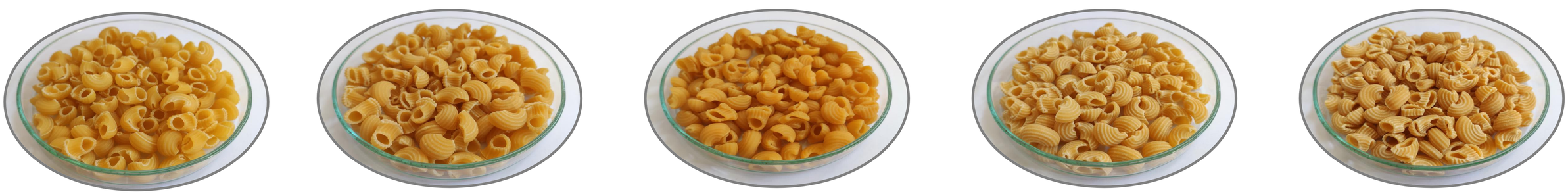


INTRODUCTION

The scientific focus on pasta products has progressively moved toward the addition of natural bioactive compounds, which resulted in improved nutritional and functional properties. Carrot waste has attracted considerable attention in recent years, because of the potential health benefits of its lipophilic bioactives, mainly carotenoids and tocopherols.

EXPERIMENTAL

Carrot waste → **Green extraction with sunflower oil** → **Encapsulation of carrot waste oil extract by freeze and spray drying techniques** → **Production of durum wheat semolina pasta enriched with encapsulated carrot waste oil extract** → **Carotenoids and tocopherols quantification before and after cooking**



Control | 10%FDI | 20%FDI | 10%SDI | 20%SDI

FDI – Freeze dried encapsulate (wall material – 100% whey protein)
SDI – Spray dried encapsulate (wall material – 79% whey protein and 21% inulin)

RESULTS

Carotenoid (mg/kg DM) and tocol (mg/kg DM) content (mean value ± standard deviation) of raw and cooked control pasta and pasta enriched with encapsulated carrot waste extract.

	Control	10% FDE	10% SDE	20% FDE	20% SDE
Raw pasta					
α-carotene	nd[a]	0.7[c] ± 0.0	0.6[b] ± 0.0	1.2[e] ± 0.1	1.0[d] ± 0.1
β-carotene	nd[a]	1.7[c] ± 0.1	1.4[b] ± 0.0	3.3[e] ± 0.3	2.7[d] ± 0.3
cis β-carotene	nd[a]	0.6[b] ± 0.1	0.5[b] ± 0.0	1.1[c] ± 0.0	1.1[c] ± 0.1
Lutein	4.9 ± 0.0	3.2 ± 0.1	3.4 ± 0.2	2.8 ± 0.1	2.9 ± 0.0
Zeaxanthin	0.3 ± 0.0	0.1 ± 0.0	0.2 ± 0.0	0.1 ± 0.0	0.1 ± 0.0
Total carotenoids	5.2[a] ± 0.0	6.4[b] ± 0.3	6.1[b] ± 0.2	8.5[d] ± 0.5	7.8[c] ± 0.5
α-tocopherol	3.9[a] ± 0.3	18.6[b] ± 0.6	20.1[c] ± 0.5	40.5[e] ± 0.2	36.9[d] ± 1.0
β-tocopherol	2.5[a] ± 0.4	4.5[b] ± 0.1	3.2[a] ± 0.3	5.0[b] ± 0.8	4.9[b] ± 0.4
γ-tocopherol	nd	nd	nd	nd	nd
α-tocotrienol	3.7[c] ± 0.3	2.4[ab] ± 0.1	2.8[b] ± 0.0	2.4[ab] ± 0.1	2.2[a] ± 0.1
β-tocotrienol	23.4[b] ± 1.5	19.1[a] ± 0.1	20.4[a] ± 0.5	19.4[a] ± 0.4	19.3[a] ± 0.4
Total tocols	33.6[a] ± 1.8	44.5[b] ± 0.7	46.5[b] ± 0.7	67.2[d] ± 1.1	63.3[c] ± 1.0

	Control	10% FDE	10% SDE	20% FDE	20% SDE
Cooked pasta					
α-carotene	nd[a]	0.5[b] ± 0.0	0.6[b] ± 0.1	0.9[c] ± 0.1	0.8[c] ± 0.1
β-carotene	nd[a]	1.2[b] ± 0.0	1.4[b] ± 0.2	2.3[c] ± 0.3	2.1[c] ± 0.2
cis β-carotene	nd[a]	0.5[b] ± 0.0	0.5[b] ± 0.0	1.0[c] ± 0.1	0.9[c] ± 0.1
Lutein	3.6[c] ± 0.2	3.1[abc] ± 0.1	3.4[bc] ± 0.3	2.7[a] ± 0.2	2.9[ab] ± 0.0
Zeaxanthin	0.2 ± 0.0	0.1 ± 0.0	0.2 ± 0.0	0.1 ± 0.0	0.1 ± 0.0
Total carotenoids	3.8[a] ± 0.2	4.9[b] ± 0.1	6.1[c] ± 0.6	7.0[d] ± 0.7	6.8[d] ± 0.4
α-tocopherol	2.9[a] ± 0.1	16.9[b] ± 1.9	19.3[b] ± 0.1	31.8[c] ± 1.3	33.0[c] ± 2.3
β-tocopherol	2.7 ± 1.6	2.7 ± 0.2	2.4 ± 0.1	4.0 ± 0.7	2.6 ± 0.6
γ-tocopherol	nd	nd	nd	nd	nd
α-tocotrienol	3.0[b] ± 0.1	2.3[a] ± 0.3	2.7[b] ± 0.1	1.9[a] ± 0.0	2.0[a] ± 0.2
β-tocotrienol	21.4[c] ± 1.0	19.4[ab] ± 0.31	20.3[bc] ± 0.0	19.3[ab] ± 0.3	18.0[a] ± 0.5
Total tocols	30.0[a] ± 0.4	41.2[b] ± 2.0	44.7[b] ± 0.2	57.0[c] ± 1.7	55.6[c] ± 2.4
Carotenoid loss (%)	26.9	23.4	0.0	17.6	12.8
Tocol loss (%)	10.7	7.4	3.9	15.2	12.2

CONCLUSIONS

- **Obtained encapsulates added significant α-carotene, β-carotene and *cis* β-carotene quantities to the enriched pasta, which were more stable than semolina carotenoids (lutein and zeaxanthin) during processing.**
- **The pasta enriched with 10% FDE/SDE had about 23% higher carotenoid contents than the control sample, while pasta with 10% FDE or SDE had 32.4% and 38.4% more tocopherols, respectively.**
- **Cooking reduced carotenoids content in all cases except for the pasta with 10% SDE. In terms of tocopherols, cooking led to minimal losses, particularly in the 10% encapsulate enriched pasta.**
- **Considering a single pasta portion (85 g cooked pasta), the 10% FDE and 10% SDE provided, respectively, 23% and 25% of the RDA for carotenoids as well as 9.6% and 10.9% of RDA for vitamin E (α-tocopherol).**