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Revalorising tomato by-products from *salmorejo* and *gazpacho* production for nutritional and functional food ingredients

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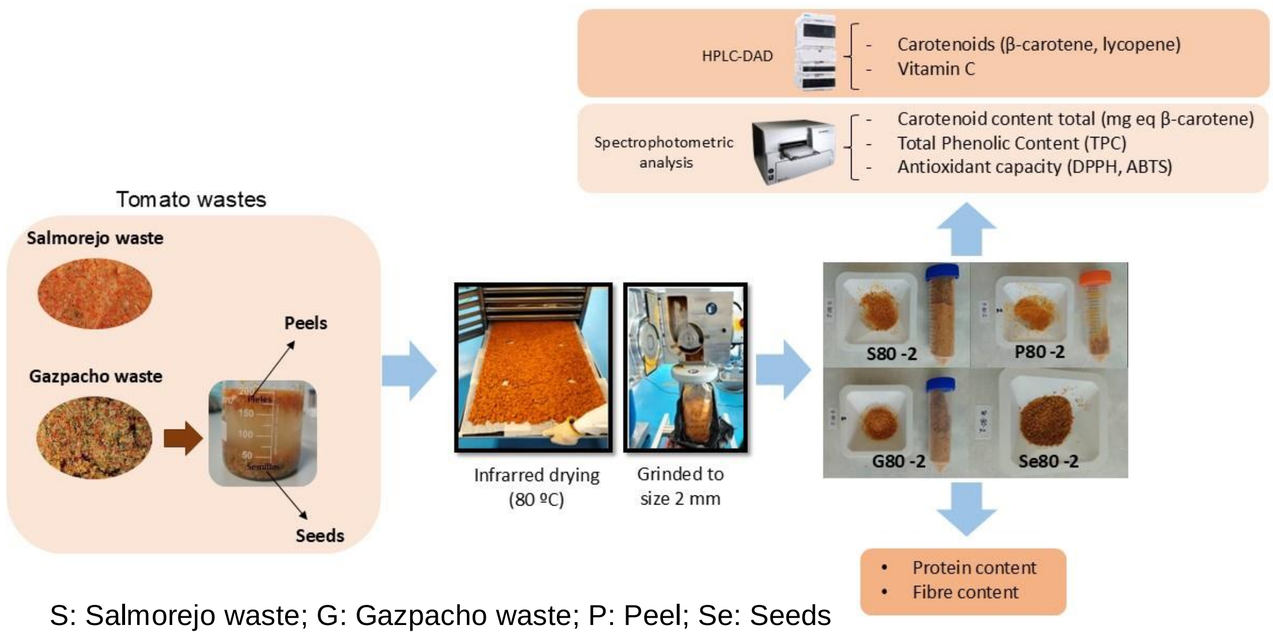
INTRODUCTION & AIM

The food industry produces huge quantities of by-products, which cause significant environmental impact. Tomato by-products, especially those generated from the production of Mediterranean cold vegetable soups such as *salmorejo* and *gazpacho*, are of particular interest. These by-products, consisting primarily of peels, seeds, and other residual materials, retain a considerable portion of the original tomato's nutrients and are rich in bioactive compounds with potential health benefits, such as carotenoids, phenolics, and dietary fiber.

Traditionally, these by-products are either discarded or used as low-value animal feed, leading to the loss of valuable nutrients. However, with growing awareness of the circular economy, there is an increasing interest in finding innovative ways to revalorize such by-products. By converting these materials into powdered forms rich in bioactive compounds, protein, and fiber, it is possible to enhance the nutritional value of a wide range of products, reducing waste and contributing to environmental sustainability.

This study aims to revalorize tomato by-products into powdered forms rich in bioactive compounds, protein, and fiber, suitable for human or animal consumption. By transforming these materials, we contribute to reducing waste and promoting sustainable practices in the food industry while creating value-added products.

MATERIAL & METHODS



S: Salmorejo waste; G: Gazpacho waste; P: Peel; Se: Seeds

RESULTS & DISCUSSION

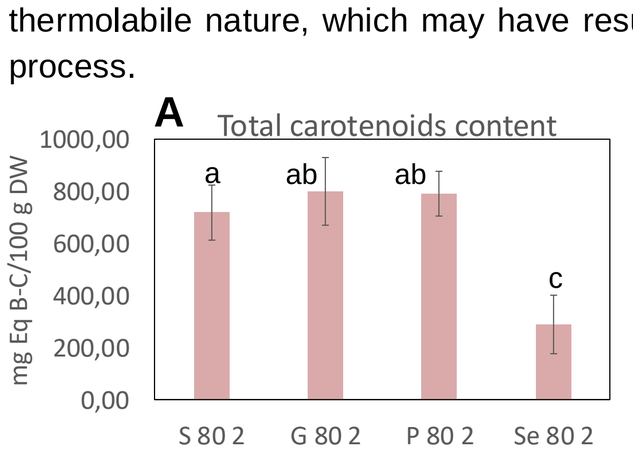
Seeds (Se80 2) are the most promising as ruminant feed ingredients, given their high protein content and balanced fiber composition (Table 1). Prototypes derived from the *gazpacho* or *salmorejo* are also suitable for human or animal consumption, as they contain a protein level slightly above the 18%, along with an adequate fiber profile. However, peels are not ideal as a feed material due to their low protein content and excessively high lignin levels (ADF), which is difficult to digest.

Table 1. Protein and fibre content of tomato by-products prototypes.

Ingredient	Protein content (g/100 g MS)	NDF (hemicelulose + celulose + lignin) (g/100 g MS)	ADF (celulose + lignin) (g/100 g MS)
S 80 2	19.70 ± 0.3 a	55.58 ± 0.3 a	35.84 ± 1.17 a
G 80 2	21.39 ± 0.6 b	61.21 ± 0.8 b	40.05 ± 1.47 b
P 80 2	8.03 ± 0.3 c	78.31 ± 0.7 c	68.55 ± 0.68 c
Se 80 2	26.47 ± 0.2 d	53.09 ± 0.2 a	31.75 ± 0.35 d

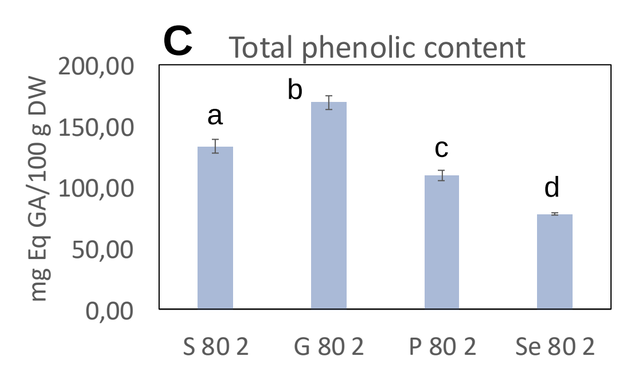
Different letters indicates significant differences ($p < 0.05$) among ingredient prototypes. *NDF: Neutral detergent fibre; ADF: Acid detergent fibre. S: Salmorejo waste; G: Gazpacho waste; P: Peel; Se: Seeds. 80: drying temperature; 2: 2 mm size.*

The highest carotenoid concentration was observed in peels, *gazpacho* and *salmorejo* by-products, with comparable levels and, lastly, the seeds (Figure 1A). Analysis of individual carotenoids revealed that *gazpacho* contained the highest amounts of both β-carotene and lycopene. Specifically, the order of β-carotene content was *gazpacho* > peels ≈ *salmorejo* > seeds, while the order for lycopene content was *gazpacho* > *salmorejo* > seeds ≈ peels. Lutein was not detected in any of the samples (Figure 1B). The low carotenoid content in seeds can likely be attributed to the fact that carotenoids are synthesized and accumulate primarily in the plastids of photosynthetic tissues, which are less abundant in seeds compared to the other matrices. On the other hand, *gazpacho* by-product showed the highest total phenolic content (TPC) (160 mg GAE/100 g), while seeds showed the lowest TPC content (70 mg GAE/100 g) (Figure 1C). Given that phenolic compounds are water-soluble, their loss during the separation process of peels and seeds—carried out via flotation—may explain the reduced content in seeds. The antioxidant capacity (TAC) followed a similar trend to that of TPC, consistent with the well-established correlation between TPC and antioxidant activity: *gazpacho* and *salmorejo* by-products exhibited higher antioxidant capacities compared to peels and seeds (Figure 1D). Vitamin C was not detected in any of the samples, likely due to its thermolabile nature, which may have resulted in degradation during the drying process.



B

	β-carotene (mg/100g DW)	Lycopene (mg/100g DW)
S 80-2	7.82 ± 1.4 a	6.38 ± 1.6 A
G 80-2	10.41 ± 1.4 b	8.41 ± 0.4 B
P 80-2	8.70 ± 0.1 a	3.98 ± 0.02 C
Se 80-2	4.21 ± 0.2 c	4.12 ± 0.3 C



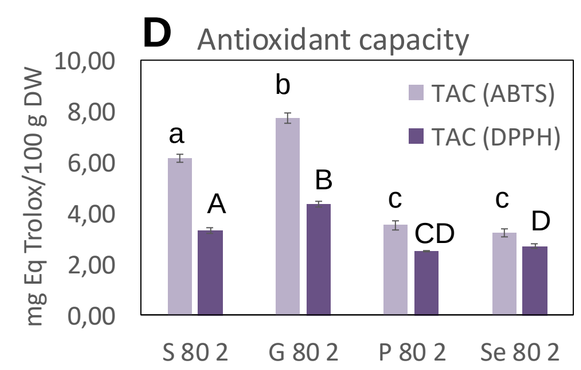


Figure 1. (A) Total carotenoid content. B) Individual carotenoids. C) Total phenolic content. D) Antioxidant capacity (ABTS and DPPH) of tomato wastes prototypes. Different letters indicates significant differences ($p < 0.05$) among ingredient prototypes. *S: Salmorejo waste; G: Gazpacho waste; P: Peel; Se: Seeds. 80: drying temperature; 2: 2 mm size.*

CONCLUSION

Gazpacho and *salmorejo* wastes are suitable as feed and food ingredients with adequate protein levels and fibre. Seeds (Se80 2) are the most promising ruminant feed ingredient due to their high protein content and balanced fiber composition. From a nutritional perspective, *gazpacho* by-product stands out for its high carotenoid and phenolic content, contributing to greater antioxidant capacity compared to other by-products like seeds and peels. Therefore, the obtained ingredients could serve to formulate innovative products for animal or human consumption while contributing to circular economy and sustainability.

ACKNOWLEDGEMENTS

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