Pastaria international

The professional information network magazine for pasta manufacturers

- www.pastaria.it
- www.pastariahub.com
- www.pastabid.com

2
2024

Colophon

Pastaria International DE
2/2024
March

PUBLISHER
Kinski Editori S.r.l.
registered office
Via Possioncella 1/1 • 42016 Guastalla
operational headquarters
Via Dall'Aglio 21/2 • 43122 Parma (Italy)
tel. +39 (0)521 1564934
fax +39 (0)521 1564935
Email redazione@pastaria.it
ROC no. 23238

EDITOR-IN-CHIEF
Lorenzo Pini

INTERNET SERVICE PROVIDER (ISP)
xPlants.it (Levata di Curtatone, Mantova)

PASTA TECHNOLOGIES GROUP

Via Martiri delle Foibe 13
35019 Tombolo (PD) - Italy
Phone: 0039 049 7968840
Fax: 0039 049 7968841
Email: info@pastatechgroup.com
Website: www.pastatechgroup.com

Gnocchi Forming Machine

Hygienic design gnocchi machines with 24 holes, 16 holes and 8 holes.

- From 500 kg/h to 1500 kg/h
- Suitable to work with hot or cold dough
- Homogeneous product during production
- 30% less request of rice flour to avoid product sticking

Follow Us:

Patrons & Sponsors

Patrons

Pastaria has obtained the patronage of the most prestigious national and international pasta manufacturer associations.

Pastaria patrons

Sponsors

The information and professional update resources that are part of the Pastaria network are freely distributed without charge thanks to the collaboration and support of leading companies operating on an international level to supply ingredients, semi-processed products, equipment and systems for manufacturing fresh/dried pasta, gnocchi and ready meals.

Pastaria sponsors

Main sponsors

MOLINO GRASSI
Creiamo qualità

1877
mininni
Industria Molitoria

SIDE
machines and plants for food industry

NEW FLAVOURS®
ITALIAN SENSATIONS

Leading sponsors

CASTIGLIONI NEDO – ITALIAN FOOD AND PACKAGING MACHINES

Frigoimpianti

LEBEN INGREDIENTS

PASTA TECHNOLOGIES GROUP

Sponsors

CAPITANIO – TRAFILE E ACCESSORI PER PASTA E SNACK

CIBUS – 22° SALONE INTERNAZIONALE DELL'ALIMENTAZIONE – PARMA.7|10MAGGIO.2024

DEMACO

Facchini GROUP • forming machines • food processing

FOODTECH S.R.L. – FOOD PROCESSING EQUIPMENT

IFT ITALIAN FOOD TECHNOLOGY

ITALGI

ITALPAST

landucci SINCE 1925

WE CAPTURE WHAT MOVES – MANE

MOLINO DeVita

RAM ELETTRONICA

SARP FOOD TECHNOLOGIES

TECHNO BINS

ZINDO – Pasta Machines & Processing

1

High amylose wheat flours for the development of healthy cereal based foods

Martina Angelicola
University of Molise

The aim of the PhD research project (winner of the Pastaria Award 2023 for the best doctoral thesis) was the development of pasta samples by replacing durum wheat semolina with high amylose wheat flours. To reach this objective, several milling diagrams with both soft and hard wheat mills were assessed and chemical and rheological characteristics were evaluated on milling products to test technological performance. For the evaluation of high amylose pasta quality, composition, cooking performance, textural analysis and expected glycaemic index were evaluated in comparison with semolina control pasta.

Introduction

Wheat is a versatile ingredient for the production of high-quality finished products (Bird & Regina, 2018). The main component of wheat is starch, which is naturally packed in granules. From a biochemical perspective, starch is a polymer of glucose consisting of amylose (20%-30%), a linear chain linked by α-1,4-glycosidic bonds, and amylopectin (80%-70%), a highly branched chain with α-1,6-glycosidic bonds (Ang et al., 2020). Previous studies (Botticella et al., 2016) have assessed the possibility of increasing the percentage of amylose in the endosperm by altering the activity of some of the key enzymes in starch synthesis. A higher concentration of amylose results in more, and less digestible, starch, known as resistant starch (RS). Resistant starch evades digestion and absorption in the small intestine, reaching the large intestine where it serves as a substrate for the gut microbiota. The fermentation of resistant starch by colonic bacteria brings about an alteration of the composition of the gut microbiota and the production of metabolites, short-chain fatty acids (SCFAs) such as acetate, propionate and butyrate, which can provide vital support to both gut cells and to other extra-intestinal tissues (Bird & Regina, 2018). Furthermore, several studies on healthy volunteers (Ang et al., 2020) have also shown that foods made with high amylose wheat help reduce post-prandial glycaemic response compared to analogous products made with conventional wheat flours.

Specifically, this research evaluated the potential application for pasta production of semolina-type flour obtained from soft wheat with a high amylose content. The results of this research support a potentially different application of soft wheat with a high amylose content for the production of functional foods.

Materials and methods

Wheat (*Triticum aestivum L.*) samples from the 2017-18 season were provided by the University of Tuscia (Viterbo, Italy). A high amylose (HA)

Liodry Foods
Food Specialists

Instant Food Revolution!

The new successful cooperation with Liodry Foods

ITALPAST, leader Company in the realization of alimentary pasta plants, and Liodry Foods, cutting-edge Italian Company for the production of ready meals and dehydrated seasonings in bags, pasta kit and pasta cup, inaugurate a new cooperation, that aims to the success in the Instant Pasta World.

The main purpose of this cooperation is the Customer: be able to provide him a 360° advice about INSTANT CUP concept, from the technical and customized choice of the production plant, to the choice of the most suitable seasoning, thanks to the support of the R&D Liodry Foods Depart., daily committed to develop personalized products and exclusive recipes, with high technological and qualitative content.

This partnership is addressed both to craft and industrial sectors, by providing them the technological know-how of more than 40 years of experience in this sector, as well as the consolidated and professional one of Liodry Foods, this representing an important business card in the dynamic sector of Instant Food!

ITALPAST
Makes the difference

www.italpast.com

wheat genotype was obtained from the wild-type Cadenza wheat line (NS, used as the control) by applying the TILLing procedure (Botticella et al., 2011).
The hardness of the caryopsis was determined by using the Perten SKCS 4100 (Perten Instruments, Sweden).
The moisture content was determined according to the ICC 109/1 method (ICC, 1995). Proteins were evaluated according to the Dumas method, AACC 46-30 (AACC, 2000) using the LECO FP-528 nitrogen determinator (Leco Corp., St. Joseph, MI, USA). Total starch, damaged starch, resistant starch and amylose/amylopectin were determined using enzyme kits (Megazyme Ltd, Ireland). Total dietary fibre was evaluated by means of the AOAC 985.29 method.
The HA and NS wheat samples were milled using a soft wheat mill (NAMAD SG2000, Rome, Italy), equipped with three break rollers (B1, B2, B3), three remilling rollers (C1, C2, C3) and six steel sieves. Previously, the wheat was conditioned to 17% (w/w) moisture (milling test 1-MT1). The HA wheat was also 6% dehulled (based on dehulling tests) to assess the reduction in ash and milled content without previous conditioning (milling test 3 - MT2). Lastly, the 6% of dehulled HA wheat was milled using a “MLU 202” durum wheat mill (Bühler, Uzwill, Switzerland) equipped with three break rollers and three remilling rollers, six steel sieves and a purifier (milling test 4 - MT3). Flour yields were expressed as a percentage of the initial product. Gluten quality was determined according to the AACC 38-12 method (Perten Instruments, Sweden), but due to the clogging of the filters during the dough washing process, the gluten was also extracted manually.
Farinograph parameters were assessed using the Brabender FarinoGraph (ICC method 115/1). The alveographic properties of the dough were assessed using the Chopin alveograph (ICC method 121), adapting the method to suit flours with a high amylose content. Gelatinisation properties were evaluated with the ICC 126/1 method, using a Micro Visco-Amylograph (MVA Brabender OHG, Duisburg, Germany). The Falling Number (FN) was determined according to the ICC 107/1 method (FALLING NUMBER mod. 1500, PERTEN), while α-amylase activity was assessed using the Megazyme kit (Ceralpha method) (Megazyme Ltd, Ireland).
Five different pasta formulations (tagliatelle) (Table 1) were prepared using the “La perfetta medium” pasta machine (La Prestigiosa, Villaverla, Italy). In order to study the effect of high amylose flour alone, the pasta was dried with a mild heat

Table 1 **FORMULATIONS FOR THE PRODUCTION OF THE PASTA SAMPLES**

Pasta samples	Durum wheat semolina (%)	High amylose semolina (%)	Water (%)
P-B30-HA-S	70	30	35.0
P-B50-HA-S	50	50	37.5
P-B70-HA-S	30	70	40.0
P-HA-S	0	100	47.5
P-S	100	0	28.0

treatment using a static dryer (Namad Impianti, Rome, Italy) at 30°C for 24 hours. The pasta was cooked in boiling tap water (at a 1/10 w/v ratio) to optimal cooking time (OCT) (ISO 2016).

The digestion kinetics of the cooked pasta was assessed *in vitro* following the method developed by Romano et al. (2016).

Cooking loss was evaluated by determining the amount of solids lost in the cooking water according to Marti et al. (2013). The water absorption index (WAI) and swelling index (SI) were calculated according to Foschia et al. (2015).

Tenacity, stickiness and clumping of the cooked pasta were evaluated according to ISO method 7304-1 (ISO, 2016).

The statistical analysis was carried out using R software (version 3.6.3). The data were subjected to analysis of variance (ANOVA) followed by the Tukey post-hoc test. Results with $p < 0.05$ indicate a statistically significant difference.

Results and discussion

The chemical composition of the two wheat samples displays major differences. The caryopsis is significantly harder in the HA wheat (89) than in the NS wheat (62), in keeping with previous observations (Botticella et al., 2018; Schönhofen et al., 2017).

The HA wheat also has a higher level of ash and protein than the NS genotype, together with a lower total starch content. The amylose content is also higher in HA wheat (58.1%) than in normal wheat (23.4%), and this is also reflected in the higher content of resistant starch (17.7% vs. 0.5% of total starch).

The milling of high amylose wheat (MT1) produced a lower flour yield (49.5%) than NS wheat (65.7%), from which a flour used as a control (NSF) was obtained.

Conventional milling is not, therefore, suitable for high amylose wheat, due to its lower flour yield and higher ash content.

Table 2 YIELD AND ASH CONTENT OF THE FLOURS OBTAINED FROM THE MILLING OF NORMAL (NS) AND HIGH AMYLOSE (HA) WHEA

FRACTIONS	NS		HA		HA		HA	
	MT1		MT1		MT2		MT3	
	Yield (%)	Ash (% d.m.)	Yield (%)	Ash (% d.m.)	Yield (%)	Ash (% d.m.)	Yield (%)	Ash (% d.m.)
Break rollers (B1+B2+B3)[a]	17.8	0.52	10.2	1.24	9.4	1.54	17.2	0.78
Remilling rollers (C1+C2+C3)[a]	47.8	0.47	39.2	0.79	45.9	0.75	15.0	0.85
Semolina	-	-	-	-	-	-	34.1	0.70±0.02
Total flour (B1+B2+B3+ C1+C2+C3)[a]	65.7	0.49	49.5	0.88	54.4	0.88	-	-
Milling waste (bran and middlings)[a]	33.0	3.58	48.8	2.86	33.7	3.25	25.6	4.28
Total flour (semolina+B1+B2+ B3+ C1+C2+C3)[a]	-	-	-	-	-	-	66.3	0.75
Dehulling waste	-	-	-	-	6	6.68± 0.03	6	6.68± 0.03

[a] *Average values calculated according to the milling yield of each fraction*

This might be a result of its lower starch content and the existence of thicker layers of bran. To reduce the ash content, 6% of the grain was dehulled prior to milling. An increase in flour yield and a drop in ash content was observed, particularly as regards the flour coming from the remilling cylinders (C1+C2+C3). So the mix of these three fractions (HAF) was selected for further analysis. Since the hardness of the HA wheat caryopsis was similar to that of durum wheat, a durum mill was used and this yielded a semolina-type flour (HAS) (yield of 34%) which was selected for further analysis. Additionally, the B2 and C1 fractions produced the lowest ash content and the highest yield, so these fractions were mixed with the semolina and subjected to further analysis (HAF(B2C1)).

Table 3 **TOTAL DIETARY FIBRE (TDF), RESISTANT STARCH (RS) AND DAMAGED STARCH (DS) CONTENTS OF THE FLOURS**

	TDF (% d.w.)	RS (% TS)	DS (% TS)
HAF	6.4 ± 0.18 a	24.6 ± 1.28 a	9.0 ± 0.94 a
HAF (B2C1)	5.8 ± 0.05 a	27.2 ± 0.37 b	8.3 ± 0.85 a
HAS	8.2 ± 0.43 b	28.9 ± 0.32 b	3.0 ± 0.49 b
NSF	2.5 ± 0.05 c	0.5 ± 0.10 c	7.2 ± 0.49 a

Different letters along the column indicate significant differences ($p<0.05$)

With regard to the chemical analysis of the flours, total dietary fibre (TDF) in the high amylose flours is more than double that found in the NS flour. Secondly, resistant starch (RS) content is higher in flour obtained from durum wheat milling. These results demonstrate that high amylose flours can be used as raw materials for the production of functional foods enriched with RS (Reg. EU 432/2012 on the reduction of post-prandial glycaemia, health claim) and fibre (Reg EC 1924/2006, nutritional claim).
The flours were also subjected to rheological analyses to test their technological performance (Table 4). The results emerging show that high amylose flours have an acceptable gluten quality and higher water absorption (WA) than normal flour, attributable to the increase in resistant starch (Barros et al., 2018). Additionally, although the innovative flours have lower strength (W) ratings than the control flour, their elasticity (P/L) is greater, and their tenacity (P) values are higher. Furthermore, due to the higher presence of amylose, which prevents the destruction of the starch granules during gelatinisation, there is a sharp decrease in viscosity compared to the control flour. These results are consistent with previous studies (Jaksics et al., 2020, Sasaki, 2005). Last but not least, high amylose flours have a very low falling number (FN) (62s), due to the composition of the starch and not to the presence of high alpha-amylase activity (Abdel-Aal et al., 2002).
Since the highest RS content was found in the semolina with a high amylose content, this flour was used in combination with the durum wheat semolina for the production of pasta, according to the formulations shown in Table 1.

ENJOY THE NEW FLAVOURS WITH OURS READY TO MIX POWDER

NEW FLAVOURS®
ITALIAN SENSATIONS

PRODUCERS OF FLAVOURINGS AND SEMI-FINISHED FOOD PRODUCTS

NEW FLAVOURS SRL
Via dell'Artigianato 7 | zona Ind.le Gioiello | 06010 Monte Santa Maria Tiberina (PG) | ITALY
info@new-flavours.com | Tel. +39 075.857.82.95 | www.new-flavours.com

Table 4 TECHNOLOGICAL PARAMETERS OF THE FLOURS

	GI	WA	DSt	W	P/L	GT	Peak of viscosity
		(%)	(min)	(10^{-4} J)		(°C)	(UB)
HAF	87	76	4.7	169	1.68	88.6	40
HAF (B2C1)	93	73.3	6.4	141	2.5	93	33
HAS	93	70.6	12.5	96	4.27	95.4	32
NSF	92	51.5	1.2	143	1.03	67.1	188

GI: gluten index, WA: water absorption, DSt: dough stability, GT: gelatinisation temperature, UF: Brabender unit

With regard to the composition of the pasta samples (Table 5), the inclusion of high amylose semolina brings about an increase in resistant starch, up to 14% RS of total starch in 100% high amylose semolina pasta, thereby qualifying for the health claim of EU Reg. 432/2012 on resistant starch. Moreover, all of the pasta samples also qualified for the nutritional claim on dietary fibre according to EC Reg. 1924/2006.

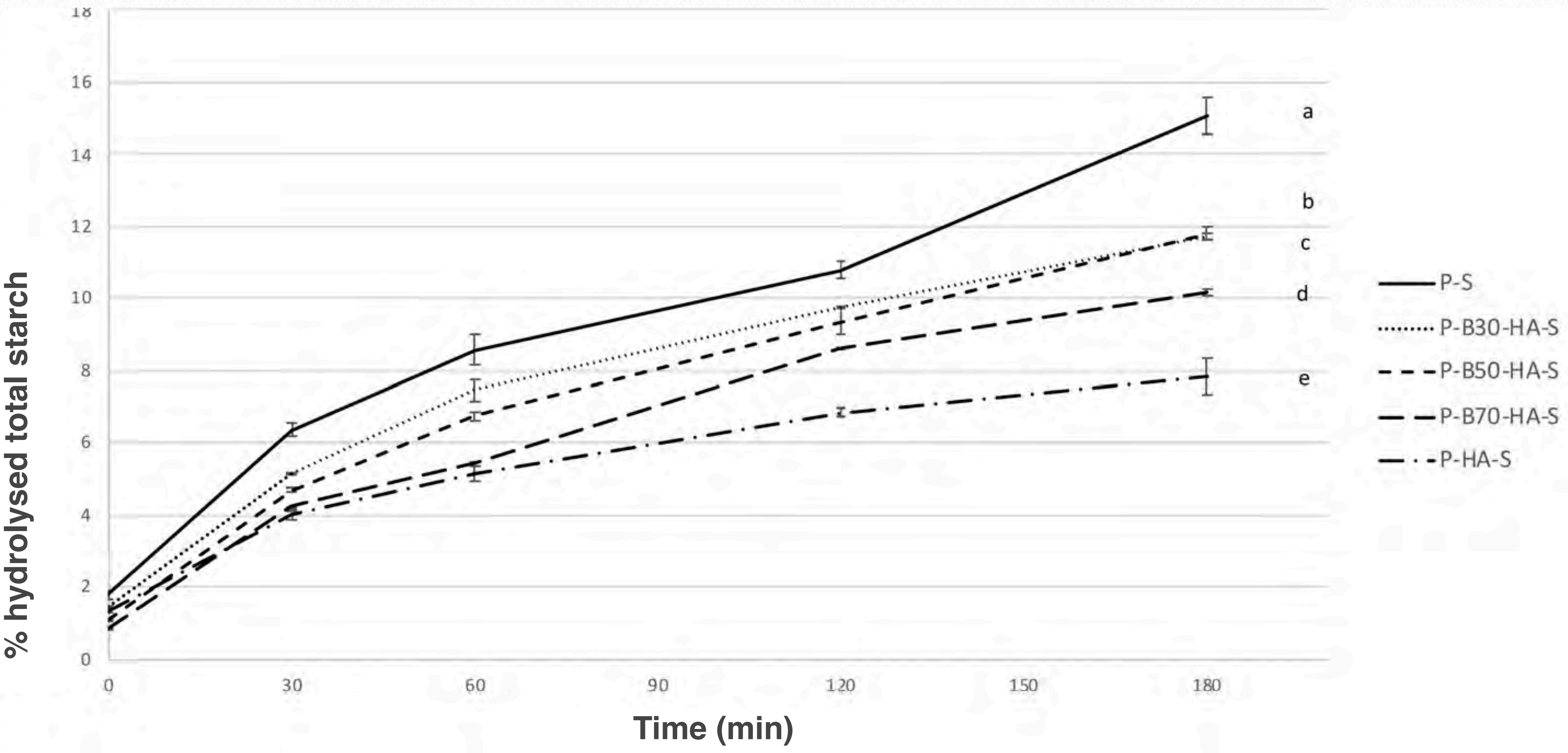
The reduction of the post-prandial glycaemic response was assessed by means of an *in vitro* test on the cooked pasta, by evaluating for each sample at different times 0' 30' 60' 120' 180' the amount of starch digested. In this way, a curve is constructed (Figure 1) from which two parameters can be derived: the hydrolysis index (HI) and the expected glycaemic index (eGI). Replacing semolina with high amylose semolina slows down

Table 5 COMPOSITION OF THE UNCOOKED PASTA SAMPLES

PASTA	PROTEINs (NX5.70)	TS	TDF	RS	
	% d.m.	% d.m.	% d.m.	% d.m.	% TS
P-B30-HA-S	12.9±0.00 b	72.0±0.05 b	4.3±0.32 c	3.4±0.63 c	4.9±0.91 b
P-B50-HA-S	12.1±0.02 c	70.2±0.56 c	6.0±0.88 b	5.4±0.52 bc	7.7±0.64 c
P-B70-HA-S	11.3±0.01 d	70.5±1.11 c	7.3±0.65 b	7.2±0.80 b	10.3±1.13 b
P-HA-S	10.3±0.01 e	64.1±0.21 d	9.3±0.30 a	9.8±0.05 a	15.3±0.16 a
P-S	13.9±0.01 a	75.9±4.12 a	3.5±0.24 d	0.5±0.01 d	0.7±0.01 e

S: total starch; TDF: total dietary fibre; RS: resistant starch. Different letters along the column indicate significant differences ($p<0.05$)

Figure 1 SPEED OF STARCH HYDROLYSIS IN THE COOKED PASTA SAMPLE



Different letters indicate significant differences (p<0.05)

the speed of starch digestion, particularly from control pasta to pasta made with 100% high amylose semolina (P-HA-S), and there is an 11% decrease in the expected glycaemic index (Table 6). Consumer acceptability of pasta enriched with resistant starch is a key parameter and was assessed by evaluating cooking quality (Table 7).

With regard to cooking losses, the increase is related to the greater capacity of amylose to leach into the cooking water, and to the weaker gluten network that is

Table 6 HYDROLYSIS INDEX (HI) AND EXPECTED GLYCAEMIC INDEX (eGI) VALUES OF THE COOKED PASTA SAMPLES

Samples	HI	eGI
P-B30-HA-S	21.4± 0.17 b	51.4± 0.09 b
P-B50-HA-S	20.4± 0.13 c	50.9± 0.07 c
P-B70-HA-S	17.8± 0.03 d	49.5± 0.01 d
P-HA-S	15.1± 0.46 e	48.0± 0.25 e
P-S	25.6±0.11 a	53.8±0.06 a

Different letters in the same column indicate significant differences (p<0.05)

Table 7 **OPTIMAL COOKING TIME AND COOKING QUALITY OF THE PASTA**

Samples	Optimal cooking time	Cooking quality						
		CL	WAI	SI	Tena-city	Sticki-ness	Clumping	Total score
	min	%	%	g water / g dried pasta				
P-B30-HA-S	07:30	6.2 ± 0.64 d	123± 1.3 C	1.66± 0.035 d	55	61	60	59
P-B50-HA-S	07:30	6.3±0.11 cd	127± 0.2 b	1.74±0.000 a	55	60	59	58
P-B70-HA-S	07:30	8.0±0.55 b	119± 0.01 d	1.70± 0.028 C	55	54	55	55
P-HA-S	07:10	10.1±0.46 a	110± 2.8 e	1.67± 0.035 d	55	20	20	32
P-S	07:50	6.5± 0.05 C	129±0.4 a	1.73±0.028 b	65	70	70	68

CL: Cooking losses, WAI: water absorption index, SI: swelling index. Different letters in the same column indicate significant differences ($p<0.05$)

responsible for amylose retention during cooking.

These factors also affect surface stickiness: in fact, during cooking there is an increased migration of amylose onto the surface of the tagliatelle, resulting in poor pasta quality.

Conclusions

The innovative flours developed have nutritional and rheological characteristics that encourage their use in the production of healthy cereal products due to their higher content of resistant starch and fibre. Specifically, in this study, semolina-type flour was used for the preparation of pasta, which, being a staple food consumed worldwide, could be a valuable vehicle for conveying human health benefits.

In order to meet nutritional, health and technological characteristics, particular blends of high amylose semolina and durum wheat semolina were developed. This resulted in the production of pasta samples with a higher content of resistant starch, thereby meeting the requirements of the health claim on resistant starch contained in EU Reg. 432/2012, given that at least 14% of the total starch is replaced with resistant starch.

Furthermore, an *in vitro* evaluation of starch digestion regarding the cooked pasta samples showed a slowing down of starch digestion in all the high amylose pasta samples, confirming the role of

DEMACO Titan Series

Easy Control

DEMACO's proprietary **ControlX** extruder management system is sophisticated in its simplicity. It's extremely easy to use with two button start up delivering unprecedented levels of user control and engineering information.

resistant starch in limiting starch hydrolysis.

The success of this strategy, however, depends on several prerequisites, first and foremost consumer acceptance. In this study, this was assessed through an evaluation of cooking quality: for the pasta samples, improvement of the texture and cooking properties is recommended, through appropriate formulations (e.g. addition of vital gluten) and processing (e.g. high temperature drying).

Bibliography

AACC, 2000. *American association of cereal chemists. In: Approved Methods of AACC*, tenth ed., 46.30. The Association, St. Paul, MN (USA). Method 26-10A, 26.41, 46-30, 66-50, 76-13.01, 32-40.01.

Abdel-Aal, E. S. M., Hucl, P., Chibbar, R. N., Han, H. L., & Demeke, T. (2002). *Physicochemical and structural characteristics of flours and starches from waxy and nonwaxy wheats*. Cereal Chemistry, 79, 458–464.

Ang, K., Bourgy, C., Fenton, H., Regina, A., Newberry, M., Diepeveen, D., Lafiandra, D., Grafenauer, S., Hunt, W., & Solah, V. (2020). *Noodles made from high amylose wheat flour attenuate postprandial glycaemia in healthy adults*. Nutrients, 12, 2171.

Barros, J. H. T., Telis, V. R. N., Taboga, S., & Franco, C. M. L. (2018). *Resistant starch: effect on rheology, quality, and staling rate*

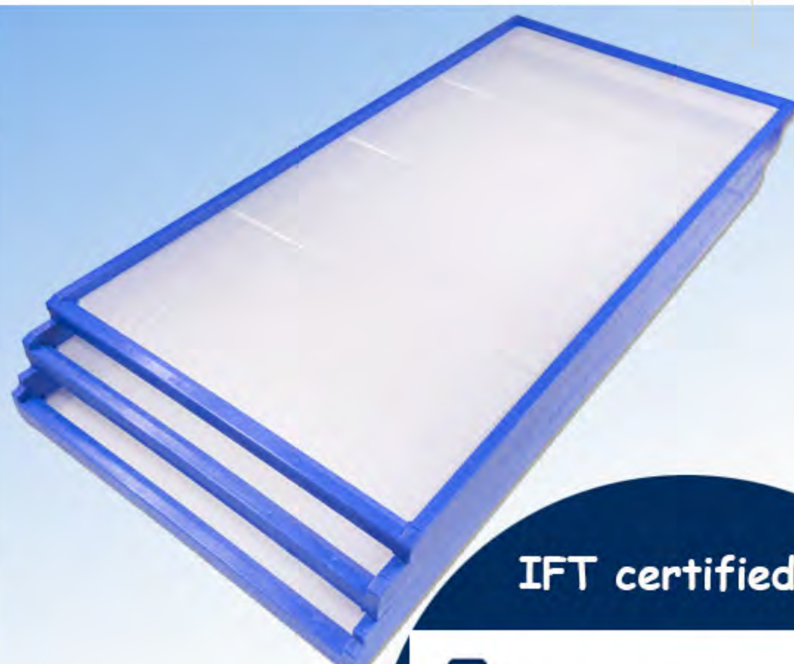
PLASTIC FRAME FOR DRYING PASTA Standard CE

IFT ITALIAN FOOD TECHNOLOGY

Successfully used in prestigious pasta maker in Italy and worldwild

Models:

TPP35: mm 1200x600xh35
TPP54: mm 1200x600xh54
TPP70: mm 1200x600xh70



IFT certified

IFS Broker

IFT S.r.l. - Via Chiassi, 20 - 46100 Mantova (MN), Italy tel. +39 0376-663667
info@iftmantova.com - www.iftmantova.com

of white wheat bread. Journal of Food Science and Technology, 55, 4578–4588.

Bird, A. R., & Regina, A. (2018). *High amylose wheat: A platform for delivering human health benefits*. Journal of Cereal Science, 82, 99–105.

Botticella, E., Sestili, F., Hernandez-Lopez, A., Phillips, A., & Lafiandra, D. (2011). *High resolution melting analysis for the detection of EMS induced mutations in wheat SbeIIa genes*. BMC Plant Biology, 11, 56.

Botticella, E., Sestili, F., Ferrazzano, G., Mantovani, P., Cammerata, A., D'Egidio, M. G., & Lafiandra, D. (2016). *The impact of the SSIIa null mutations on grain traits and composition in durum wheat*. Breeding Science, 66, 572– 579.

Botticella, E., Sestili, F., Sparla, F., Moscatello, S., Marri, L., Cuesta-Seijo, J. A., Falini, G., Battistelli, A., Trost, P., & Lafiandra, D. (2018). *Combining mutations at genes encoding key enzymes involved in starch synthesis affects the amylose content, carbohydrate allocation and hardness in the wheat grain*. Plant Biotechnology Journal, 16, 1723–1734.

Foschia, M., Peressini, D., Sensidoni, A., Brennan, M. A., & Brennan, C. S. (2015). *How combinations of dietary fibres can affect physicochemical characteristics of pasta*. LWT – Food Science and Technology, 66, 41–46.

ICC, 1995. *Standard Methods of the International Association for Cereal Science and Technology*. Method 109/1, approved 1960, revised 1979.

ISO, 2016. International Standard ISO 7304-1:2016, *Durum Wheat Semolina and Alimentary Pasta — Estimation of Cooking Quality of Alimentary Pasta by Sensory Analysis*. ISO, Geneva, Switzerland

Jaksics, E., Paszerbovics, B., Egri, B., Rakszegi, M., Tremmel-Bede, K., Vida, G., Szilveszter, G., Renàta, N., & Tömösközi, S. (2020). *Complex rheological characterization of normal, waxy and high-amylose wheat lines.* Journal of Cereal Science, 93, 102982.

Marti, A., Seetharaman, K., & Pagani, M. A. (2013). *Rheological approaches suitable for investigating starch and protein properties related to cooking quality of durum wheat pasta.* Journal of Food Quality, 36, 133–138.

Romano, A., Mackie, A., Farina, F., Aponte, M., Sarghini, F., & Masi, P. (2016). *Characterisation, in vitro digestibility and expected glycemic index of commercial starches as uncooked ingredients.* Journal of Food Science and Technology, 53, 4126–4134.

Sasaki, T. (2005). *Effect of wheat starch characteristics on the gelatinization, retrogradation, and gelation properties*. Japan Agricultural Research Quarterly, 39, 253–260.

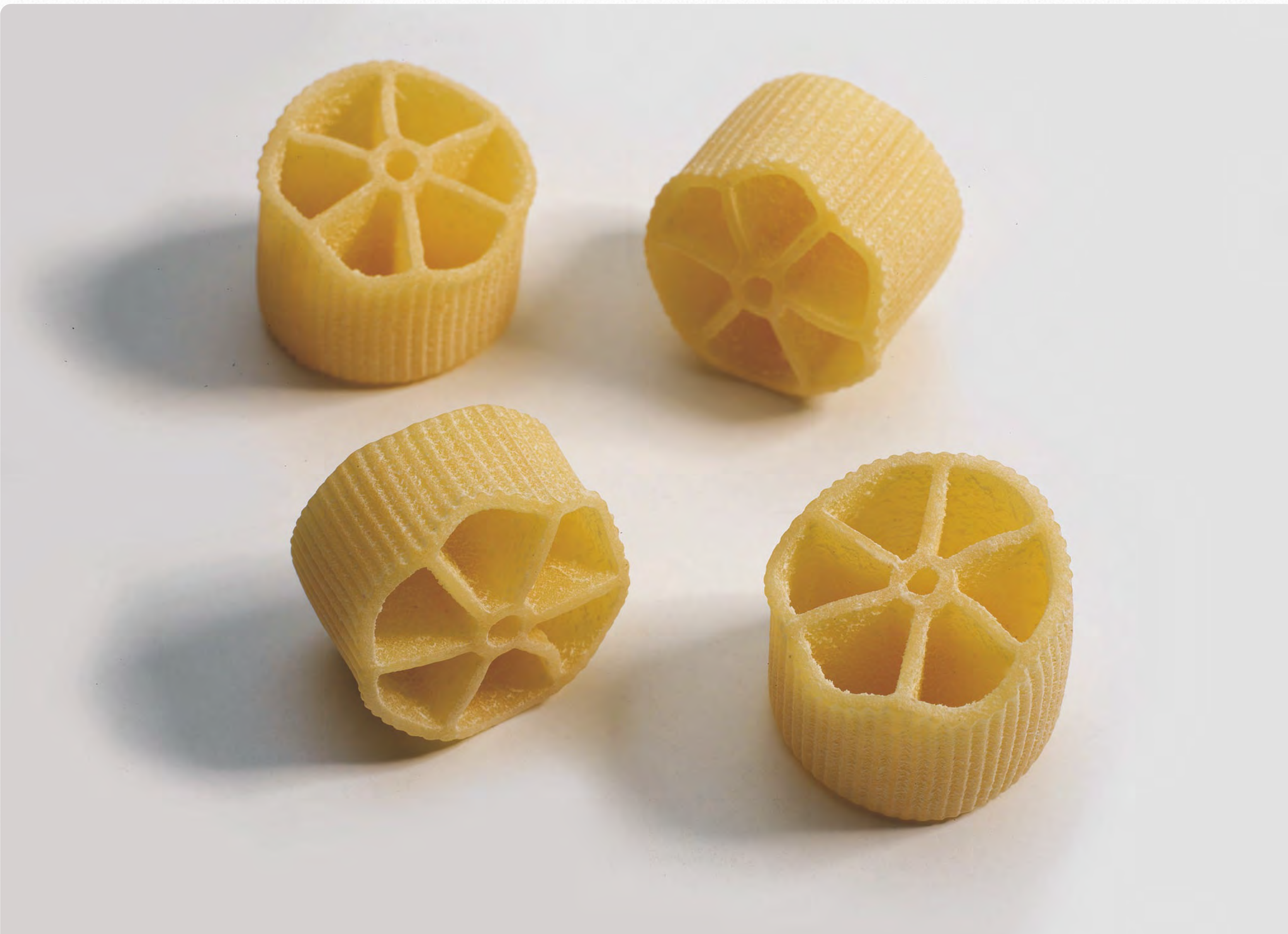
Schönhofen, A., Zhang, X., & Dubcovsky, J. (2017). *Combined mutations in five wheat STARCH BRANCHING ENZYME II genes improve resistant starch but affect grain yield and bread-making quality*. Journal of Cereal Science, 75, 165–174.


BRAZILIAN
BISCUITS, PASTA
AND INDUSTRIALIZED
BREADS & CAKES
ASSOCIATION
TOGETHER WE
ARE STRONGER
We represents more than 40 billion in sales per year, 3.5 million tons of products consumed and 158k tons of brazilian Biscuits, Pasta and Industrialized Breads & Cakes around the World.
abimapi
.COM.BR
Brazilian Manufacturers Association of Biscuits, Pasta and Industrialized Breads & Cakes
BRAZIL IS IN THE TOP 10
IN THE BAKERY INDUSTRY
3rd place for biscuits in the world;
3rd place in the dried pasta in the world;
9th package bread in the world.
Follow us on:

2

Report on the Italian pasta industry

Pastaria Centre for Economic Research



The Mediobanca research area has published its first report on the Italian pasta industry. Let's take a look at what has emerged.

The turnover of Italian pasta factories grew by 5% in 2023. A result that incorporates an increase in sales of 5.9% on the domestic circuit and 4.1% abroad.

Such are the – still provisional – data elaborated by Mediobanca's Research Area, illustrated in its first report dedicated to the pasta industry in Italy and including a detailed analysis of the entire supply chain and a focus on the financial results of the leading national production companies.

Fresh pasta producers, struggling in 2022, achieved the best performance last year, with a 10.1% increase in sales, a growth rate that consolidates fairly similar trends in the domestic and cross-border markets.

In the “core” dry pasta segment, on the other hand, turnover grew by a more modest 3.3%, demonstrating a much stronger domestic (+5.1%) than cross-border (+1.5%) dynamic.

Looking at a cross-section of the various types of production enterprises, the evolution of the turnovers does, nevertheless, show differentiated trends, including a counter-trend featuring a 0.2% decrease for pasta factories that mainly use large-scale distribution as a sales channel. A result – experts explain – brought about by the impact of inflation on consumer purchasing power, which has prompted major retailers to curb price increases and resort to promotional leverage, whenever possible.

On the other hand, the use of domestic grains, with 100% Italian pasta, proved to be a winning strategy, albeit a niche product, experiencing a 7.4% growth in turnover over the past twelve months, above average for the sector.

The growing importance of private labels

Thanks to manufacturer's brands, pasta factories have increased their sales by 6.1% overall, compared to a 2.9% increase in the private label circuit. In the domestic market, however, turnover has decreased by 2% for private label pasta, while increasing by 8.8% for manufacturer's brands.

In addition to the sales figures, investments were also positive; according to an initial assessment they grew by 7.2% last year. Again there were conflicting trends between producers of dry pasta (+9%) and pasta factories specialising in the processing of fresh products (-0.2%), penalised, however, by lower liquidity. Investments in advertising also grew, with their share of turnover rising from 1.8% in the previous year to 3% in 2023.

Balance sheets with more compressed margins due to the weight of extra costs

The analysts of the Milan merchant bank report that the historical analysis of the balance sheet data shows great variability in the companies' profitability indicators. After its positive performance in 2020 (6.9%), the EBIT margin, i.e. the ratio of net operating margin to turnover, fell to 4.6% in 2021, only to be further whittled down to 3.3% the following year, with the impact of costs, following the commotion triggered by the soaring increases in wheat prices, which rose from 77.1% of the turnover in 2019 to 82.9% in 2022.
In the three-year period 2019-2021 – continue the experts – fresh pasta producers reported more satisfactory margins than those observed in the dry pasta circuit, an average of 1.2 percentage points higher. This situation was, however, reversed in 2022.
It is important to note that the financial leverage (ratio of financial debt to equity) of the largest pasta producers worsened, shifting from 92.5% in 2019 to 97.2% in 2022, after having reached its lowest level in 2020 (68.3%). On average, fresh pasta producers tend to have greater recourse to borrowing, with leverage greater than one, although this is gradually improving.
Another aspect to be considered is that in 2022, the turnover of the largest Italian pasta factories racked up a nominal increase of 28.2% over 2021, with 13.8% of the total turnover involving foreign-controlled companies. Taking the change in producer prices into account, the real 2022 sales growth of the entire industry was +8.5% (+5.2% domestic sales, +11% exports).

Southern Italy, leader for dry pasta

An analysis of the context provides an interesting overview of the geography of the Italian factories, 35.6% of which are located in the South and the Islands, where the bulk of national durum wheat is produced. More than half of the dry pasta factories (52.4%) are concentrated in

landucci SINCE 1925

zamboni

Southern Italy, two-thirds of which are in Campania (there are four pasta factories in the municipality of Gragnano alone) and Apulia. On the other hand, fresh pasta production is negligible (with a share of only 2.9% in the South), a supply chain that makes extensive use of soft wheat flour, with half of the factories being located in the regions of the North-East and approx. 40% in the macro-subdivision of the North-West.
The pasta factories in Southern Italy, with an average turnover of €115 million, are the largest in Italy, followed by those in the North-East (€105 million). In the South, the dry pasta producers hold pride of place (€125 million), while in the North East, the XXL size of the turnover is the prerogative of the fresh pasta producers (€137 million).
It should be noted that specialisation in the pasta industry has enabled Italy to take a prominent role at a European (and global) level, accounting for 72.4% of the sector's turnover in the EU-27, for 63.6% in terms of number of companies and for 58.7% in terms of numbers of employees.
In Europe, Italy also confirms its position as the largest exporter of pasta (it also holds the record worldwide) with 2.1 million tonnes in 2022, equal to 77% of the EU total, an increase of 14.3% over a five-year period (+12.2% intra-EU market, +16.4% non-EU market).

Pasta factories with over 30 years' experience

Overall, the 74 pasta factories in Mediobanca's sample have an average age, from their founding date, of 32 years, with the oldest factories in the dry pasta circuit (37 years, as opposed to 25 years for those specialising in fresh pasta). The geographical variations reflect these disparities, reaching 39 years for production companies in the South, and 25 and 33 in the North-East and North-West.

LSD, king of the retail channels

The distribution dynamics, to which the Report devotes an in-depth thematic analysis, confirm the market's high concentration in large-scale distribution (LSD), accounting for around three-quarters of pasta consumption. Private labels account for 31.1% of sales in the LSD sector and 34.8% of the volumes. The average discount compared to manufacturer's brands is 25% for fresh pasta and 15% for dry pasta, a gap that reflects lower brand loyalty, as a rule, in the fresh circuit and a private label share-volume of 52.1%, compared to 30.6% for dry pasta, with peaks of 58.3% for fresh egg pasta and 54.5% for gnocchi.

Production figures show that dry pasta accounts for about 95% of the total volumes and 85% of the “ex-factory” value, against 5% and 15%, respectively, for fresh pasta.

Widespread adherence to certifications among pasta factories

Although only 14% of companies draft a sustainability report, the use of process and product certifications is widespread. Analysts explain that the quality standards most in use among Italian pasta manufacturers are those issued by the Global Food Safety Initiative (GFSI) to guarantee food safety. As many as 91.8% producers have certifications of organic origin, since they have dedicated lines. Furthermore, to meet the needs of international markets, 54.1% of pasta factories adopt Kosher certification standards (compatibility with Jewish tradition), while 32.8% have Halal certification (compatibility with the principles of the Islamic religion). A third of the companies in the sample certify that their products conform to vegetarian and vegan criteria (VeganOK standard), while the production of gluten-free pasta is the subject of specific certifications in 18% of the companies, the most widespread of

which is that issued by the AIC (Italian Coeliac Association).
The absence of GMO (genetically modified) products is attested by the North American Non-GMO Project standard adopted by 13.1% of the companies, while 9.8% have obtained certification attesting that pesticides have not been used on the agricultural crops.
Other certifications include Fairtrade, which affirms the importance of ethical values and respect for the rights of producers and workers in developing countries, and the FSC seal, which covers packaging made in compliance with responsible forest management.
On average, around 70% of the material used by major Italian pasta manufacturers for pasta packaging is recyclable.

Governance, lean shareholding structures and prevalence of family control

With regard to ownership structures and governance, the study shows that 81.1% of the equity of the largest pasta factories, worth more

than €1.7 billion, is under family control; 11.5% (€250 million) is in the hands of foreign groups and 7.4% (€160 million) those of purely financial investors (slightly more than half is in the hands of private equity funds).
“Lean” and top-down board structures prevail, with only 12.4% of boards consisting of five members.
A total of 247 members sit on the BoDs of the 74 largest pasta companies in Italy, so the median is 3 members each.
Single-member boards, where management is delegated to the sole director, exist in 21.9% of the enterprises. Given that a further 24 companies (a third of the total) are characterised by the presence of a Managing Director who also holds the office of President, the proportion of companies with a governance structure in which operational mandates are entrusted to a single person rises to 54%.
The average age of board members is 57.8 years. The presidency (65.5 years), also when associated with the office of Managing Director (63 years), is held by relatively older individuals. Similar findings for the position of Sole Director, which is also over 60 years of age (63.9 on average).

Few women in top positions

Regarding the composition of board members by gender, women occupy 16.6% of the positions, but are significantly fewer in top positions: 13.3% in the case of the presidency and 8.3% if combined with the position of Managing Director, rising to 22.1% in the case of the position of Director. No women occupy the position of Vice-President in the major Italian pasta producers.
Lastly – the analysis observes – the fresh pasta sector has been impacted by major M&A (mergers and acquisitions) transactions, with an Italian private equity fund bringing about the creation of an Italian hub for the production of fresh pasta, gnocchi and ready meals.
The frozen fresh pasta segment, on the other hand, has attracted the interest of an American fund with the same goal of creating a “Made in Italy” hub capable of covering the international markets.

TECHNO BINS

From semolina to pasta a unique storage specialist

Our experience is the result of forty years of work serving the milling industry and the main plant builders in the pasta sector, which allows us to customize storage systems to serve the entire production chain of the pasta factory.

The only company which supplies all types of metal silos, round and prismatic – smooth and corrugated. We will find the suitable solution to optimize your spaces and prevent the accumulation of dust and cross-contamination between products.

Innovative battery of completely smooth and self-cleaning pasta cells, compliant with the main HACCP and MOCA regulations and subjected to quality control – ISO 9001 and UNI EN 1090 certified company.

TECHNOBINS s.r.l.
Via R. Cartesio, 2
42122 Reggio Emilia - Italy
Phone +39 0522 943002
info@technobins.it

www.technobins.it

3

Fiera Pastaria set to make its début

Editorial staff

Stazione Leopolda

Just a few weeks to go now to Fiera Pastaria, the exhibition exclusively dedicated to pasta and organised by our magazine, set to make its début in Florence on 20 and 21 May in the prestigious setting of the Stazione Leopolda. All the latest news on technologies, ingredients and services for the production of all types of pasta will be shown to operators in the sector by the main international suppliers. The exhibition coincides with the 8th edition of the Pastaria Festival, offering an impressive programme of conferences. This will make the two days in Florence an unmissable event for anyone operating in the pasta supply chain.

The countdown is now on for the first edition of Fiera Pastaria.
The new exhibition, organised by the specialised magazine Pastaria, will be making its début in Florence on 20 and 21 May, in the attractive setting of the Stazione Leopolda, the first railway station to open in the Tuscan capital in 1848, now used to host prestigious events.
With just a few weeks to go, preparations are in full swing for the pavilions of the Stazione Leopolda to host leading companies operating at global level in the supply of machines, systems and accessories, ingredients and services for making pasta, ranging in size and type, from fresh pasta shops and small artisan workshops to the large dry pasta industry and producers of pasta ready meals.
The advantage for visitors to Fiera Pastaria operating in the pasta production field and its supply chain is that they will find a single, compact exhibition space where they can explore both the most interesting new technologies offered by the market and a significant variety of ingredients and semi-finished products offered by the best-known and long-established companies in the sector.
"We are extremely satisfied to note the significant, widespread interest in our new event on the part of companies and players in the supply chain.
We believe that the strong support of leading suppliers, the close collaboration with international associations and – we hope – widespread participation on the part of pasta manufacturers (also from abroad) will make Fiera Pastaria – right from this first edition – a unique exhibition event, offering an extraordinary opportunity for professional growth", said Lorenzo Pini, editor of Pastaria, who came up with the idea for the event.
"Our aim is to make Fiera Pastaria an exclusive exhibition, small in size (compared to the better-known trade fairs in the sector) but highly specialised: a single, small-scale fair conceived exclusively for professional pasta manufacturers".
"We invite all pasta makers to come and visit Fiera Pastaria", Pini added.

The eighth edition of the Pastaria Festival held at the same time

On the same days, the Stazione Leopoldo venue will also be hosting the 8th Pastaria Festival, the most eagerly anticipated annual training, professional development and networking event in the pasta production sector.
The sector's key players – associations,

professional bodies, universities, pasta factories and experts – will meet in Florence to share their knowledge and expertise in pasta production during a day of meetings, workshops, presentations, lessons and much, much more.
The Pastaria Festival programme will be published in April in Pastaria and on the portal of the magazine.

To visit Fiera Pastaria

Fiera Pastaria will be held in Florence on 20 and 21 May 2024, from 9.00 a.m. to 6.30 p.m.
The Stazione Leopolda event venue is in Via Viale Fratelli Rosselli 5, near Florence city centre, and is easy to reach both by car and by public transport.
Indications to reach Fiera Pastaria.

By train
The recommended railway station is Porta al Prato, next to the Stazione Leopolda. Santa Maria Novella railway station is about one kilometre from the venue: 5 minutes by taxi, 10 minutes by bus, lines 1 and 9 (departing from Via della Scala).

By plane
Amerigo Vespucci Florence Airport. The Stazione Leopolda is a 15/20-minute taxi ride from the airport.

By car
A11 Firenze-Mare motorway: Firenze Nord exit.
A1 motorway, from Milan/Bologna, or Naples/Rome: recommended exit Firenze Nord. From the exit, continue along Viale Guidoni and Viale Redi, following the signs for the city centre, direction Porta al Prato.

By bus
Lines: 29 - 30 - 35 - 57 (Stazione Leopolda stop)
Lines: C2 - C3 (Leopolda stop)

By tram
From Via Alamanni (behind Santa Maria Novella railway station), stop: Leopolda (first stop).

To exhibit

Suppliers interested in exhibiting their products at Fiera Pastaria please note that the last available spaces are filling up rapidly.
For further information, please call the Pastaria offices on +39 0521 1564934, or request an admission form info@pastaria.it.

FIERA
PASTARIA
INTERNATIONAL PASTA FACTORY
SUPPLIERS TRADE FAIR
& FESTIVAL
A single trade fair for
all pasta factory suppliers.
Together at the eighth
Pastaria Festival.
Come to Fiera Pastaria and visit the stands of international suppliers of ingredients, flavourings, semi-finished products, machinery, equipment, accessories and services for the production of pasta.
Join us to take part in the myriad meetings, seminars, presentations and round tables on pasta that make up the Pastaria Festival programme.
To book an exhibition space: T. +39 (0)521 1564934
For information: info@pastaria.it
STAZIONE LEOPOLDA
FLORENCE, 20-21 MAY 2024
SAVE THE DATE
Organised by
Pastaria
PASTARIA FESTIVAL
Sharing know-how on pasta manufacturing
With the collaboration of
abimapi
APPAFRE
Associazione produttori pasta fresca della piccola e media impresa
appf
Associazione Produttori Pasta Fresca
IPO
INTERNATIONAL PASTA ORGANISATION
UN.A.F.P.A.
Unione Italiana Food
qualità, gusto e piacere
Uifra
UNIÓN DE INDUSTRIALES FIDEEROS DE LA REPÚBLICA ARGENTINA

4

New formulas of fresh egg pasta enriched by bioactive compounds

Tiziana Amoriello[1], Francesco Mellara[1], Stefania Ruggeri[1], Roberto Ciorba[2], Danilo Ceccarelli[2], Roberto Ciccoritti[2]

1. CREA – Research Centre for Food and Nutrition, Rome
2. CREA – Research Centre for Olive, Fruit and Citrus Crops, Rome

Nowadays, consumers orient their food choices to meet their nutritional needs and keep themselves in optimal health, while striving to give priority to sustainable foods. With this in mind, the aim of this study was to develop a new formulation of fresh egg pasta using phenol-rich extracts from the by-products of artichoke processing, obtained through ultrasound-assisted extraction combined with food engineering techniques. Lastly, the effect on pasta quality of the addition of the extract was evaluated.

Introduction

International strategies, such as the 2030 Agenda for Sustainable Development, the FAO Strategic Framework 2022-31 and the European Green Deal, are striving to achieve more efficient agri-food systems. This goal can be pursued by implementing sustainable development strategies through the protection of natural resources, the reduction of energy and water consumption, and the promotion of by-products of production processes with a view to creating a circular economy. (United Nations, 2015; European Commission, 2019; FAO, 2019). Recent estimates have shown that the fruit and vegetable sector is the one that produces the most waste (approx. 40% of production does not reach the end user), but this waste could be retrieved and reused as a source of numerous bioactive compounds (Caldeira et al., 2019). Part of the waste derives from transformation processes and consists of the non-edible parts of the products. For example, the stems, leaves and outer bracts of the artichoke (Cynara scolymus L.). Chemically, the artichoke is mainly made up of complex and simple carbohydrates, a good mineral content and numerous bioactive compounds. The biosynthesis of these latter substances requires the plant to expend energy but, as they are accumulated indiscriminately in the plant's tissues, they are already a source of waste when stored in non-edible portions. The interest in artichoke processing waste stems from the fact that Italy is the world's largest producer of artichokes (with approx. 23.8 % of world production) (FAOSTAT, 2021). Additionally, the artichoke – and therefore also its non-edible parts – is credited with having hepatoprotective, cardioprotective, anti-inflammatory and antioxidant functions as well as the ability to inhibit cholesterol biosynthesis and low-density lipoprotein oxidation (Fallah Huseini et al., 2012; Llorach et al., 2002; Sánchez-Rabaneda et al., 2003). Thus, in recent years, numerous technologies for extracting compounds of interest have been evaluated, following the principles of green chemistry i.e., using food grade solvents and sustainable physical processes such as ultrasound. Extracts rich in bioactive compounds can be successfully used in the food industry, e.g. in the pasta industry, a sector in which Italy is a world leader. In particular, according to a study by Allianz Trade, the fresh pasta segment continues to be very popular with consumers (Ognibene, 2023) and is a sector wide open to innovation. Against this backdrop, this study aims,

STEAM PASTEURISER

Model: AV

Output: from 300 kg/h up to 2000 kg/h

The linear steam pasteuriser is a machine for industrial pasta factories, optimized to process fresh and filled pasta. Thanks to the adjustable belt speed, it's possible to precisely manage the treatment time to match the product. During the process,the chamber will be saturated with steam, ensuring an effective and high-quality treatment.

with the aid of green solvents (water and ethanol) coupled with ultrasound-assisted extraction techniques, to recover phenolic compounds from the production waste of the artichoke processing industry, for use as a raw material in the production of fresh egg pasta (fettuccine). The enrichment effect on the pasta produced was studied by evaluating the total phenol content, before and after cooking the fettuccine, the sensory characteristics (colour) and shelf life.

Materials and methods

By-products of organic artichokes (cv "Campagnano") were considered, consisting of the stems, leaves and outer bracts of the artichoke itself, stored in the refrigerator for 8 hours at 5 °C, and subsequently dried in an oven at 60 °C for 24 hours. The dried material was ground with a Bühler MLI 203 mill (Milan, Italy) to obtain a flour with a grain size between 400 and 500 nm. The flour was used for the ultrasound-assisted extraction (UAE) of phenolic compounds (TPC), following optimisation of the process itself. In short, through the application of Response Surface Methodology (RSM), extraction process parameters such as solvent composition (X1), extraction time (X2) and extraction temperature (X3) were optimised, as described by Amoriello et al. (2022). With regard to the other ingredients used for the formulation of the pasta, commercial soft wheat flour (Molini Progeo, Masone, Italy), durum wheat semolina (F.lli De Cecco di Filippo Fara S. Martino S.p.A., Fara S. Martino, Italy) and eggs (Gruppo Novelli srl, Terni, Italy) purchased from large-scale retailing were used.

Table 1 shows the ingredients and the respective percentage concentrations used in the innovative formulation of fresh egg pasta.

The doughs were obtained by mixing the different formulation of ingredients using a rotary mixer (Kenwood KPL9000S, Hampshire, UK) until a homogeneous product was obtained. At this stage, the dough was laminated to a thickness of 1 mm and then cut using a roller sheeter. 50 g of fettuccine for each type of pasta was analysed immediately, while a further 50 g aliquot was first cooked for 5 minutes in 0.75 L of boiling water and then analysed. Chemical and physical determinations were carried out, as reported in the study of Amoriello et al. (2022). All tests and determinations were conducted in triplicate and values expressed as mean and standard deviations. Analysis of variance was conducted by means of the non-parametric Kruskal-Wallis test with a


WE
CAPTURE
WHAT
MOVES
MANE

Table 1 **PERCENTAGE OF THE INGREDIENTS USED IN THE FORMULATION OF FRESH EGG PASTA (PI)**

(%)	P1 (control)	P2	P3 (control)	P4
Semolina	35	35	0	0
Soft wheat flour	35	35	63	63
Eggs	20	20	37	27
Water	10	0	0	0
Artichoke extract	0	10	0	10

significance difference level of 5%. The effect of the artichoke extract on pasta shelf life was evaluated by image analysis. The pasta samples were observed and photographed daily for 8 days. The images showed the deterioration of the samples and the appearance of mould, once the colonies reached a diameter of 3 mm. Samples were considered "non-conforming" as soon as a colony appeared, as described by Zardetto et al. (2022). The time taken for mould colonies to reach a diameter of 3 mm is called "rejection time". The differences between the shelf-lives of the fettuccine were evaluated by applying a generalised linear model (GzLM) with two variability factors (type of pasta and day).

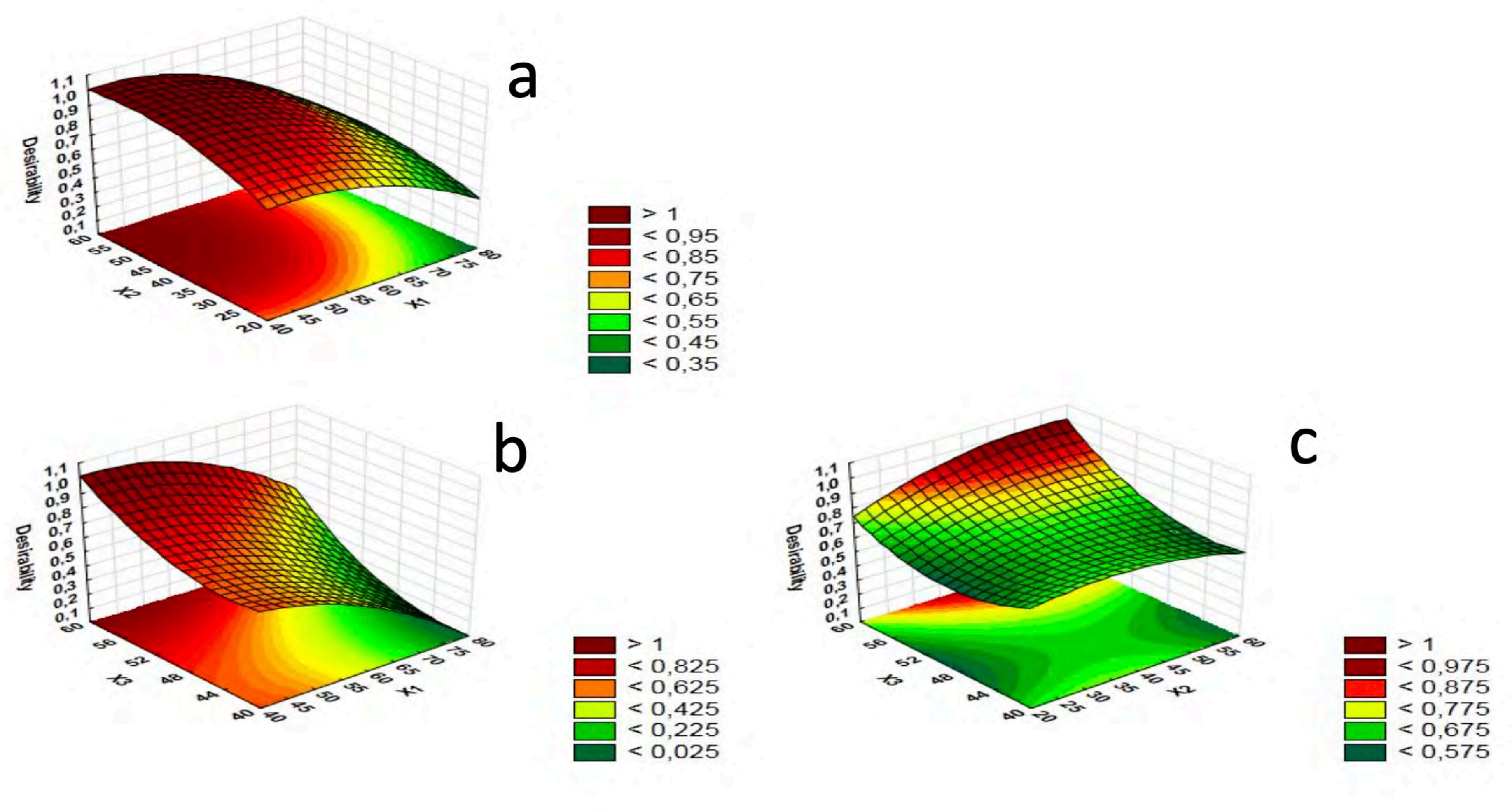
Results and discussion

The optimal conditions (solvent composition, time and temperature) for ultrasound-assisted extraction of phenolic compounds from artichoke waste was estimated using Response Surface Methodology (RSM), the result of which is shown in Figure 1. Briefly, RSM enabled the calculation of the optimal values for process variables X1 (solvent composition), X2 (extraction time) and X3 (extraction temperature), so as to obtain the maximum extraction yield of phenolic compounds. In particular, the maximum yield of phenols was observed when the solvent consisted of 50% water and 50% ethanol, for a time interval of 60 minutes at a temperature of 60°C.

The theoretical yield estimated by the model for the TPCs was 22.4 ± 0.2 mg GAE g^{-1} d.w., a value not statistically different from that obtained experimentally (22.5 mg GAE g^{-1} d.w.).

Ultrasound-assisted extraction produced a phenol content 88% higher than that obtained with a conventional extraction technique (11.9 ± 0.1 mg GAE g^{-1} d.w).

Figure 1 **RESPONSE SURFACES OBTAINED BY RESPONSE SURFACE METHODOLOGY**



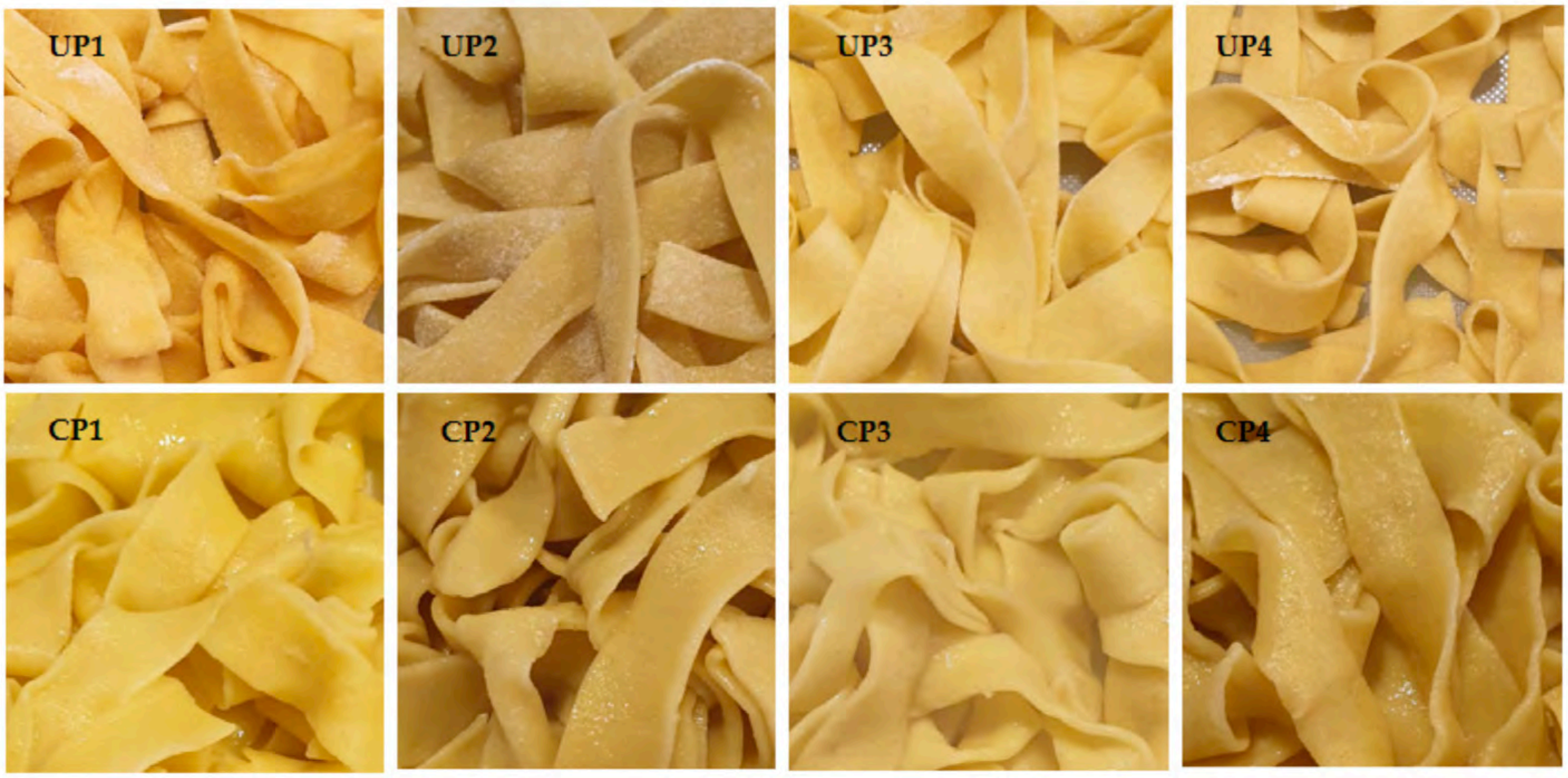
The areas in red indicate the parameter values (X1=solvent composition; X2=extraction time; X3=extraction temperature) with the greatest phenol extraction power

The increase in total phenol yield may be due to cavitation at the solid-liquid interface, induced by the ultrasound. As is well known, cavitation facilitates the release of extractable compounds and improves mass transfer by destroying the plant cell wall. Similar results were also observed by Pasqualone et al. (2017). Chromatographic analysis of the extract showed a predominance of dicaffeoylquinic acid (32.8 ± 0.6 µg CAE g^{-1} d.w.) and chlorogenic acid (14.1 ± 0.2 µg CAE g^{-1} d.w.) among the phenolic compounds. The extract obtained was used in the formulation of pastas whose visual characteristics are shown in Figure 2 and Table 2. Visual observation of the fettuccine showed good pasta quality for all of the formulations. With regard to the colorimetric analysis carried out according to the CIELab international standard, enrichment with extracts from artichoke waste (ABP) in conjunction with the addition of semolina during the kneading phase brought about a significant decrease in brightness (L*) in all of the pastas. The value of a* (a* = + red, – green) did not, however, vary to a

RAM® ELETTRONICA 50 1974/2024

Via Ospedaletto km 1,700C.P. 325 76123, Andria (BT) | Italy
Tel. +39 0883 553719/20 | information@ramelettronica.it | ramelettronica.it

Figure 2 **PHOTOS OF THE ENRICHED PASTAS OBTAINED: (UPi) UNCOOKED PASTAS AND (CPi) COOKED PASTAS**



significant degree with the addition of ABP. In contrast, significant differences were found between the uncooked pastas (U) P1-P2 and P3-P4, which could be attributable to the presence of semolina in the dough. With regard to the cooked pasta samples (C), significantly higher b* values (b* = + yellow, - blue) were found, compared to the control samples (CP1 and CP3). Pastas made with added semolina also showed higher values of the yellow index, probably due to a higher amount of carotenoids deriving from the semolina itself. Furthermore, all cooked pasta samples had higher yellow values than those observed in the uncooked samples. The increase in the a* and b* parameters can be attributed to the high carotenoid content of the egg yolk, which significantly impacted the two colorimetric coordinates analysed. Similar colour variations between cooked pastas were also observed by Teterycz et al. (2019).

With regard to the differences in the CieLAB coordinates between the cooked and uncooked samples, these are most likely due to variations in the pasta matrix as a result of the cooking itself, which may have generated losses of the compound in the cooking water.

Table 3 shows the concentration of TPC in the different pasta formulations before and after cooking. As expected, the two pasta formulations enriched with the extract (P2 and P4) showed a higher content of total phenols than the non-enriched pastas (P1 and P3). Irrespective of the type of formulation, cooking significantly reduced

Table 2 CIELAB COLOUR CO-ORDINATES (L* BRIGHTNESS, A* RED INDEX B* YELLOW INDEX) OF ARTICHOKE WASTE (ABP), OF PASTAS WITH DIFFERENT ENRICHMENTS, UNCOOKED (UPi) AND COOKED (CPi)

Sample	L*	a*	b*
ABP	61.50 ± 0.62 e	-0.17 ± 0.15a	17.76± 0.05 f
UP_1	87.90±0.66 b	-2.30 ± 0.18 e	26.84 ± 1.04 bc
UP_2	88.55 ± 0.41 ab	-2.11 ± 0.03 e	24.50 ± 0.92 cd
UP_3	89.25 ± 0.48 a	-1.20±0.04 b	23.00 ± 1.22 de
UP_4	88.58 ± 0.19 ab	-1.26±0.05 b	22.08 ± 0.69 e
CP_1	87.15±0.39 b	-3.28 ±0.09 g	31.86 ±0.87 a
CP_2	80.37 ± 0.89 d	-1.97 ±0.06 d	25.77± 0.78 c
CP_3	86.91 ±0.29 b	-2.77 ±0.08 f	27.85±0.31 b
CP_4	83.19 ± 0.31	-.1.79 ± 0.08 c	23.79 ±0.41 d

Different letters in the same column indicate statistically significant differences (p<0.05)

the TPC content, especially for the non-enriched pastas (-71% in P1 and -70% in P3). In contrast, in the enriched pastas a smaller reduction in phenolic compound content was observed (55% in P2 and 64% in P4). The different behaviour of the pastas during cooking could be related to the different forming of the gluten network during the kneading process, due to the different chemical characteristics of the raw material used. In fact, the quality of the gluten is generally affected by the amino acid composition of the proteins and by the ratio of amylose to amylopectin in the starch, which greatly depend on species, genotype, environmental conditions and agronomic practices.

Moreover, as reported by Palermo et al. (2014), cooking can induce many chemical and physical changes in food, including a reduction in polyphenol contents due to thermal degradation and their solubilisation in the cooking water.
The results as regards the effect on product shelf life of enriching fresh egg pasta with the extracts are shown in Figure 3.
The appearance of fungal colonies was monitored for eight days. These appeared on the control samples (P1 and P3) after 6 days of being stored in the refrigerator, on day 7 for sample P2 and on day 8 for sample P4. Similar results were previous observed also by Zardello et al. (2022) on fresh pasta stored at 5 °C. The time and

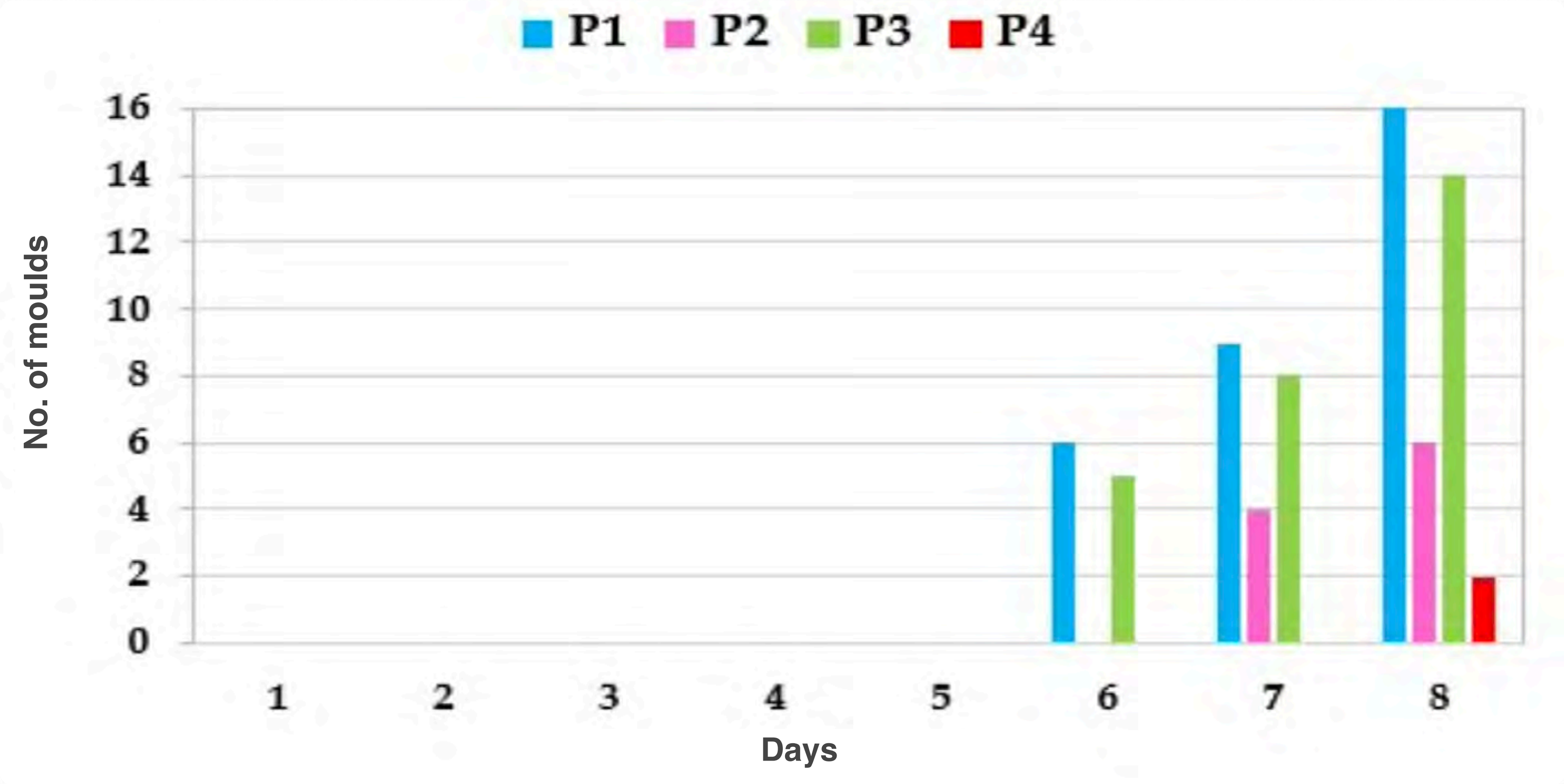
Table 3 **TOTAL PHENOL CONTENT (TPC) IN EGG PASTAS AT DIFFERENT LEVELS OF ENRICHMENT BEFORE (UPi) AND AFTER COOKING (CPi) AND RELATED PERCENTAGE CHANGE (ΔTPC)**

Sample	TPC-UPi (mg GAE/g d.w.)	TPC-CPi (mg GAE/g d.w.)	ΔTPC (%)
P1	1.86± 0.03 c	0.54± 0.02 c	-71
P2	2.05 ± 0.05 a	0.73±0.04 b	-64
P3	1.92±0.03 b	0.57± 0.03 c	-70
P4	2.04 ± 0.02 a	0.91 ± 0.02 a	-55

Different letters in the same column indicate statistically significant differences (p<0.05)

type of pasta significantly affect the shelf life of the samples, supporting the theory that phenolic extract may have a high antimicrobial potential that positively impacts the shelf life of the product. As is well known, the length of the product's shelf life is of paramount importance since the data in literature show shorter shelf life times for fresh egg pasta in controlled atmosphere at 4 °C than those observed in the present study (Angiolino et al., 2019).

Figure 3 **DEVELOPMENT OF THE PRESENCE OF MOULD ON THE COOKED SAMPLES OF THE 4 TYPES OF PASTA, SUBJECTED TO REFRIGERATION FOR 8 DAYS.**



Frigoimpianti
italian food technology

2021 30° 1991

impianti progettati e realizzati su misura

Tunnel di pastorizzazione
con controllo di temperatura e umidità
Ideali per pasta fresca

ALTA EFFICIENZA ENERGETICA

ASPETTO PIÙ NATURALE
DOPO IL TRATTAMENTO

GRANDI PRODUZIONI
IN PICCOLI SPAZI

PASTORIZZATORE "PVR"
rettilineo

TUNNEL "D" in caduta

TUNNEL Spirale "S"

PASTORIZZATORE
"COMPACT" spirale

FRIGO IMPIANTI s.r.l.
Via dei Lecci, 18 - Bastia Umbra - Perugia - Italia
Tel. + 39 075 801 04 89 - info@frigoimpianti.it
www.frigoimpianti.it

Conclusions

This study has shown that artichoke by-products are particularly rich in phenolic compounds, particularly hydroxycinnamic acids, which can be easily extracted using green chemistry approaches such as the use of food grade solvents coupled combined with ultrasound-assisted extraction. Optimisation of the extraction parameters (choice of solvent, extraction temperature and extraction time) resulted in higher yields of phenolic compounds than those obtainable through the classic maceration process. As regards the enriched pastas produced, visually they looked very good and biochemically they were invested with a higher antioxidant power than that observed in the control pastas. It can be reasonably presumed that phenol enrichment also positively affected the shelf life of the product.

Bibliography

Amoriello, T., Mellara, F., Ruggeri, S., Ciorba, R., Ceccarelli, D., Ciccoritti, R. 2022. *Artichoke by-products valorization for phenols-enriched fresh egg pasta: A sustainable food design project*. Sustainability, 14(22), 14778.

Angiolillo, L., Spinelli, S., Conte, A., Del Nobile, M.A. 2019. *Extract from broccoli* *byproducts to increase fresh filled pasta shelf life*. Foods, 8, 621.

Caldeira, C., De Laurentiis, V., Corrado, S., van Holsteijn, F., Sala S. 2019. *Quantification of food waste per product group along the food supply chain in the European Union: A mass flow analysis*. Resour. Conserv. Recycl.

European Commission. Communication from the Commission to the European Parliament, the European Council, the Council,the European Economic and Social Committee and the Committee of the Regions – *The European Green Deal*. European Commission. 2019. Available online: https://eur-lex.europa.eu/resource.html?uri=cellar:b828d165-1c22-11ea-8c1f-01aa75ed71a1.0002.02/DOC_1&format=PDF (accessed on 23 August 2022).

FAO. Strategic Framework 2022-31. FAO. 2019. Available online: http://www.fao.org/3/cb7099en/cb7099en.pdf (accessed on 23 August 2022).

FAOSTAT. 2021. Available online: http://faostat.fao.org (accessed on 23 August 2022).

Fallah Huseini, H., Kianbakht, S., Heshmat, R. 2012. *Cynara scolymus L. in treatment of hypercholesterolemic type 2 diabetic patients: A randomized double-blind placebo-controlled clinical trial*. J. Med. Plants 11, 58–65.

Llorach, R., Espín, J.C., Tomás-Barberán, F.A., Ferreres, F. 2002. *Artichoke (Cynara scolymus L.) byproducts as a potential source of health-promoting antioxidant phenolics*. J. Agric. Food Chem., 50, 3458–3464.

Ognibene S., 2023. *Pasta fresca*. Available online: https://www.google.com/search?client=firefox-b-d&q=pasta+fresca+cresce+anche+nel+post-covid (accessed on 19 Settembre 2023)

Palermo, M., Pellegrini, N., Fogliano, V. 2014. *The effect of cooking on the phytochemical content of vegetables*. J. Sci. Food Agric., 94, 1057–1070.

Pasqualone, A., Punzi, R., Trani, A., Summo, C., Paradiso, V.M., Caponio, F., Gambacorta, G. 2017. *Enrichment of fresh pasta with antioxidant extracts obtained from artichoke canning by-products by ultrasound-assisted technology and quality characterization of the end product*. Int. J. Food Sci. Technol., 52, 2078–2087.

Sánchez-Rabaneda, F., Jáuregui, O., Lamuela-Raventós, R.M., Bastida, J., Viladomat, F., Codina, C. 2003. *Identification of phenolic compounds in artichoke waste by high-performance liquid chromatography-tandem mass spectrometry.* J. Chromatogr. A, 1008, 57–72.

Teterycz, D., Sobota, A., Kozłowicz, K., Zarzycki, P. 2019. *Substitution of semolina durum with common wheat flour in egg and eggless pasta.* Acta Sci. Pol. Technol. Aliment., 18, 439–451.

United Nations. *Transforming Our World: The 2030 Agenda for Sustainable Development. United Nations.* 2015. Available online: https://www.un.org/ga/search/view_doc.asp?symbol=A/RES/70/1&Lang=E (accessed on 23 August 2022).

Zardetto, S., Fregonese, M., Pasini, G. 2022. *Effects of modified atmospheric packaging configuration on spoilage mould growth in damaged packages of fresh pasta*. J. Food Eng., 314, 110760.

5

Pasta beyond tradition: technological

Maria Fiorenza Caboni
Department of Agrifood Science and Technology (DISTAL)
University of Bologna

Pasta, a staple food of the Italian tradition, is also increasingly asserting itself on international markets as a versatile and also nutritionally positive food, given the fact that cereals are the basis of the Mediterranean Diet. Pasta also has the potential to become a functional food due to the fact that it can be enriched with bioactive molecules and nutritionally positive components. Here are some considerations and a case study that can be examined for further development of the sector.

Introduction

Pasta is an FMCG, with excellent nutritional characteristics and great versatility in the kitchen, which has had pride of place on Italian tables for centuries, and is also very popular outside Italy: in the last 10 years, in fact, exports have more than doubled (Il Sole 24 ore 23/03/23). Since it is so simple to use and can easily be combined with a wide range of different sauces, this product offers great potential for innovation, not only in terms of shape, but also in terms of formulation. The very fact that it is consumed almost daily provides a lever of nutritional enrichment likely to give further impetus to its consumption. The market is, in fact, diversifying and increasing its products, taking nutritional claims into account.

State of the art and considerations

A great deal of research has been done on improving the quality of pasta (Marconi et al. 1999 and 2000; Marconi and Carcea 2001; Samaan et al. 2006; Saujanya and Manthey, 2006), through drying techniques and the use of non-conventional types of flour, not to mention gluten-free pasta that, thanks to the selection of the ingredients and to technology, are no longer the choice for gluten-intolerant consumers alone, but also furnish an appealing alternative for the ordinary consumer (Sajid Mushtaq et al., 2023, Romano et al., 2021). An intervention strategy already in place, but still with great potential, is that of enrichment, i.e. the addition to the dough of substances with positive nutrition connotations: an apparently simple action, which can, however, involve a number of pitfalls and difficulties.

The dose of the bioactive substance added to the dough: it is of paramount importance that the quantity of the enriching compound that the consumer ingests with a portion of pasta be a significant quantity of the nutrient in relation to its recommended intake, if it is to meet the consumer's expectations.

Furthermore, since pasta is a product with a long shelf life, enriched pasta must meet this requirement as well: throughout the expected shelf life of the enriched product, the bioactive compounds added to the dough must also remain unaltered until the pasta is consumed.

Moreover, the retention factor of the nutrient in the pasta must also be verified; any losses that might occur both during the production process of the enriched pasta and during its preparation must, therefore, be taken into account. Cooking, which can be considered as a hot

extraction, can in fact become a critical issue since, if the nutrient is water-soluble and not retained and bound to the dough, there is a real risk of substantial losses in the cooking water during the preparation of the dish.
Finally, it is of fundamental importance to assess the sensory characteristics of the enriched product, from both the rheological and the taste perspective: although consumers are aware of the different formulation, they must still find the product to their liking; otherwise there will be no follow-up after the initial purchases.

Case study

An example of this is the enrichment of pasta with omega-3 fatty acids. Omega-3 fatty acids (also called ω3 or n-3) are a family of polyunsaturated fats (PUFAs) found in plants and certain animal tissues; for decades now they have been known to be essential and beneficial to human health. Given that they are compounds that the human body is unable to synthesise and must be consumed with food, it has been shown that Western diets are unlikely to meet daily requirements, which vary according to age, physiological condition and physical activity. The recommended intake of omega-3 is between 200 and 500 mg/day, taking into account that the two physiologically essential molecules are EPA and DHA, while ALA can be converted by the human body into EPA and DHA, but the conversion factor is between 5 and 15% (Burns-Whitmore et al, 2019). So in recent years, the food industry has been offering foodstuffs enriched with omega-3 fatty acids. Enriching pasta with these compounds is, therefore, very attractive precisely because of the likelihood of constant daily consumption. When assessing requirements, moreover, the omega-6/omega-3 ratio should be considered and should be no higher than 5, but over the last 100 years, Western populations have witnessed a major shift in this ratio, towards omega-6 fatty acids (Bjerve et al 1989; Eurodiet 2000; ANC 2001; EFSA 2005). Due to the fact that omega-3 fatty acids are highly unsaturated, they are very susceptible to oxidation reactions that can seriously impair the quality, functionality and even the sensory characteristics of the fats themselves and the foods containing them. Functionalisation, as mentioned above, must be done in such a way that the valuable molecules added reach the consumer's plate intact.
In the production of pasta, omega-3 fatty acids have been used in


WELCOME TO FOODLAND
cibus.it | cibus@fiereparma.it | follow us on
FIERE DI PARMA
FEDERALIMENTARE
Servizi s.r.l.
CRÉDIT AGRICOLE
Fiere di Parma official Bank
Regione Emilia-Romagna

microencapsulated (Gouin, 2004) – and hence powder – form, due to their fragility and in order tto facilitate mixing them into the semolina, in order to protect them from contact with oxygen. The quantities to be added to the formulation were then selected so as to obtain pasta with 73.7, 140.8 and 235.8 mg/100 g dry product; the evaluation of the effective enrichment, compared to the control sample, and of the retention factor, carried out on dry and cooked pasta alike, showed a retention factor, in cooked pasta, of approximately 90% (Iafelice et al. 2008). The sensory evaluation of the spaghetti enriched up to the intermediate dose of the supplement, carried out according to Anzaldúa-Morales (1994), did not find any differences compared to the control for: colour, chewability, flavour, taste, aftertaste and general acceptability. For the spaghetti enriched with the higher dose, a strange taste was perceived, resulting in a lower approval rating.

The n-6/n-3 ratio for the control spaghetti was 14, while the spaghetti enriched at the highest dose had a value of 3, as a consequence of the increase in EPA and DHA and, considering an 80 g portion, the fortified spaghetti can provide, depending on the level of enrichment, from 63.7 to 198.8 mg of omega-3 fatty acids, which corresponds to 10-31% of the daily recommended intake (650 mg/day) (ISSFAL 2004).

The fatty content of enriched spaghetti is between 20 and 40% higher than that of conventional pasta, depending on the level of enrichment, with a higher degree of unsaturation (Iafelice et al. 2008).

In order to test the shelf life of the product, the pasta, both conventional and enriched, was packaged in its typical transparent polymer material and kept for 12 months under the light of a supermarket display case, while a control of the same samples was kept under the same room temperature conditions, but protected from the light. Sampling was carried out after 3, 6, 10 and 12 months, and the peroxide number was measured on the fat extracted. The results showed that the two groups of samples were not significantly different, but after 6 months of exposure in both cases the lipid fraction had oxidised, whereas in the two groups of samples protected from the light, the peroxide number was still below 10 at the end of the experiment (12 months) (Verardo et al. 2009) (Table 1) and the state of preservation was therefore optimal.

It thus emerged that, with the aid of the appropriate strategies, a fatty substance, even if unsaturated, can be integrated into a long shelf-life product such as pasta; the experience gained from this experiment

Table 1 EVOLUTION OF PEROXIDE NUMBER IN SAMPLES OF CONVENTIONAL AND OMEGA-3 FATTY ACID-ENRICHED PASTA, STORED UNDER A FLUORESCENT LAMP. (FROM VERARDO ET AL., 2009)

Months	Peroxide number	
	control	enriched
0	8.2	7.1
3	14.9	13.7
6	23.7	37.4
10	39.6	40.3
12	38.8	43.4

indicates that the formulations that can be devised must be fully evaluated in order to obtain products that meet consumer expectations. Other viable supplementation projects exist, and some of the most interesting can be considered already available, but with room for improvement, especially with regard to ingredients, for some of which a bioavailability assessment would be appropriate. Of course, improvements in quality and functionality can be greatly boosted by technological developments in fractionation and purification techniques so as to develop more effective supplements.

Prospects

The caryopsis itself has a very rich composition of bioactive compounds of excellent nutritional value, which are not part of the composition of conventional pasta production; in addition to the outer layers, which can be used to increase the amount of total fibre, attention can be focused on the germ, which accounts for only 2-3% of the entire caryopsis in terms of quantity. This part contains 15% fat and over 30% protein (albumins and globulins), but, despite the proven evidence of the beneficial effects of wholegrain, its incorporation into pasta presents a challenge, due to the fact that the milling process promotes – even significantly – the hydrolysis of the triglycerides, thereby increasing the sensitivity of this matrix to oxidation, which, as mentioned above with regard to omega-3 fatty acids, seriously compromises the sensory and nutritional characteristics of the product in which it occurs (Marzocchi et al., 2022). So the prospect of fractionating and stabilising the germ is of great interest, as it would enable the separated, purified and stabilised components to be reintroduced

FROM THE LAND OF WHEAT · SINCE ·

PASTA ARGENTINA

· 1860 ·

La mejor Pasta de Sudamérica

VIENE DE
NUESTRO TRIGO

SALE DE
NUESTRO CORAZÓN

into the pasta-making process to produce pasta with a composition enriched in protein, fats (possibly microencapsulated) and soluble fibre, from wheat.

Conclusions

Supplementation with bioactive substances appears to be a very valid strategy for improving the nutritional characteristics of suitable foodstuffs, such as cereal products in general and pasta in particular; food enrichment is all the more beneficial when focused on foods that are normally part of the daily diet. Enrichment, as already mentioned, has to take many factors into account: technology, sensory aspects, shelf life, retention and packaging, which have to be conceived for a product with different characteristics and issues compared to traditional foods. In conclusion, it can be said that functionalisation requires a holistic approach to the food itself, which, to all intents and purposes, should be considered a new product, even if it fits into the gastronomic tradition in terms of occasions for use, preparation and sensory characteristics.

Bibliography

ANC2001 https://hal.archives-ouvertes.fr/hal-00900366/document

Anzaldúa-Morales, A. (1994) La evaluación sensorial de los alimentos en la teoría y la prática. Pages 133-134. Acribia: Zaragoza, Spain.

Bjerve, K.S. et al. (1989) In: Galli, C., Simopoulos, A.P. (eds) Dietary ω3 and ω6 Fatty Acids. Springer, Boston, MA.

Burns-Whitmore B., Froyen E., Heskey C., Parker T., San Pablo G. et al. (2019) Alpha-linolenic and linoleic fatty acids in the vegan diet: do they require dietary reference intake/adequate intake special consideration?; Nutrients, 11, 2365.

EFSA 2005: https://www.efsa.europa.eu/en/corporate/pub/ar05

Eurodiet 2000: Eurodiet core report – European Commission https://ec.europa.eu/health/archive/ph_determinants/life_style/nutrition/report01_en.pdf

Gouin, S. (2004). *Microencapsulation: Industrial appraisal of existing technologies and trends*. Trends in Food Science and Technology, 15, 330–347.

Iafelice, G., Caboni, M.F., Cubadda, R., Di Criscio, T., Trivisonno, M.C., Marconi, E. (2008) *Development of Functional Spaghetti Enriched with Long Chain Omega-3 Fatty Acids*; Cereal Chem. 85:146–151.

ISSFAL. 2004. http://www.issfal.org.uk/Welcome/PolicyStatement3.asp

Lenihan-Geels G., Bishop KS (2016) *Alternative origins for omega-3 fatty acids in the diet – Omega-3 Fatty Acids*. Springer.

Marzocchi S., Caboni M.F., Miani M., Pasini F. (2022) Wheat germ and lipid oxidation: an open issue; Foods, 11, 1032.

Romano, A., Ferranti, P., Gallo, V., Masi, P. (2021) *New ingredients and alternatives to durum wheat semolina for a high quality dried pasta*; Current Opinion in Food Science, 41, 249–259.

Sajid Mushtaq, B. Zhang, W., Al-Ansi, W., ...,Walayat, N., Wang, L.(2023) *A Critical Review on the Development, Physicochemical Variations and Technical Concerns of Gluten Free Extrudates in Food Systems*; Food Reviews International, 39, 2806–2834.

Verardo V., Ferioli F., Riciputi Y., Iafelice G., Marconi E., Caboni M.F. (2009) *Evaluation of lipid oxidation in spaghetti pasta enriched with long chain n– 3 polyunsaturated fatty acids under different storage conditions*; Food Chem., 114, 472-477.