Healthy & tasty pasta: is it a possible mission?

What to pay attention to if you want a perfect product

by **Antonio V. Gaddi**
MD, PhD

Pasta's composition is complex. In contrast with other foods like greens, meat, or fish, pasta have no whole cells in it. In cellular, complex foods, the quality and the organoleptic features strongly depend on conservation process. Fresh fish, meat or vegetables, for instance, have a better taste and nutritional contents than canned or frozen food.
When it comes to pasta, instead, the production and the conservation process go through a number of stages that differs from those of *cellular foods*, and each phase can strongly affect the final result.

The way wheat is processed can change the quality of pasta

As a consequence, for a very high-quality pasta, three main characteristics make the difference:

a - the quality of the raw material; in this case the durum wheat semolina1, that depend on the genetic stream of the wheat used, the cultivation or harvesting methods and so on.

b - how the semolina is processed.

c - how the product is conserved; the conservation process starts immediately after the harvesting of the wheat and ends when the packages of pasta are opened before cooking.

Whereas point (a)[2] and (c) affect the final quality of all foods, point (b) strongly characterizes pasta; the way wheat is processed and the way flour is kneaded in a dough are the phases that have the major impact on what we eventually eat. Starting from the same ingredients, in fact, we can have very different results: many events can happen during each step of pasta production; every one of these contribute to create different varieties of pasta each one with its peculiarities.
Scientific studies in the past properly identify the two main variables of the working process - namely humidity and temperature - that primarily influence the drying phase (1), and consequently the quality of the final product; those findings have been widely presented in this journal (2).
On the other hand, there are many other processes that may influence the quality of the final product. These passages do not only contribute to the development of the organoleptic properties of the different varieties of pasta, but are crucial in determining the nutritional value of this food. In other words, the way pasta is produced may have an impact on health and wellbeing.

Additives: pros and cons

In order to have a healthy & tasty pasta several approaches have been tried. Commercial R&D labs and food technologists focuses mainly on those additives that may be added to the dough in the different steps of production[3]. We can cite among the others the olive pomace oil, lyophilized tomato, tomato juice, amaranth flour and other (3-6).

The way pasta is produced may have an impact on health and wellbeing

We cannot censure this approach, but we cannot stand neutral: the pasta produced with the use of these technologies may be different from what consumers want. In addition, those products hardly resemble the traditional Italian food, with its taste, versatility and nutritional value. Thus, the use of the proper producing techniques should be fostered, in order to improve the quality of pasta from a scientific, nutritional and economic point of view. The key point is that the production processes should not do violence on the dough. We use the word violence not light-heartedly. Every step of the process in fact can disrupt the quality of the pasta, hardly stressing the dough and its fine molecular balance. Machines used in pasta production exert forces (like pressure or heat) that may alter the fragile binding present in the molecules that form the dough, like amides or gliadin. The equilibrium among those forces is fragile as well, and it is very difficult to find and calibrate. The tertiary and quaternary structure of the glutenin depend on pre-production factors (as the genetic characteristics of the wheat used, or the molecular weight and number of subunits). But it also depends on the conformational changes induced by treatments, like the level of hydration, the temperature, the

[1] A coarse-ground wheat that produce a high-quality flour especially used for pasta.

[2] The quality of the wheat remains crucial when pasta is considered as the quality of the dough and therefore of the final product deeply depend of the type of grain used; every producer can choose a different variety of wheat to obtain different quality of pasta.

[3] We reported just some of these studies as an example of the different approaches tried to obtain a better product. These examples show how many kind of additives – some of them particularly peculiar – have been tried.

kind and amount of the forces (mechanical energy, and mechanical forces, like pressure, stretching and so on) used. A number of reliable studies underline how these processes impact on how gluten is shaped (7, 8). The interaction between gluteins and gliadins form gluten with the proper hydration (namely a 1:2 ratio) and thanks to the application of mechanical energy. Those permit the macromolecular mixing and have an effect also on finer level: during the kneading, these micro-forces, among other effects, create and destroy disulfide bridges, and alter the hydrophobic bindings that condition the three-dimensional arrangement of the macromolecules in the presence of water. The amount and quality of proteins is crucial (9).
Of course the actual process is much more complicated than that, and this is only one of the many processes that contribute to create a good pasta. The best product is the one with a perfect structure where intact granules of starch[4] float inside the almost foamy structure of gliadin.

Thanks to Pasta Pietro Massi - a pioneer in pasta production[5] holding a number of patents[6] related to different production - we discovered that all the processes have an impact on the final result. Each process has an effect on the final result so to severely affect what we eventually eat. The use of the wrong forces in the different phases of production can alter the outcomes in term of taste and amount and quality of the nutritional components.

Into the lab

The scanning electron microscopy can give an experimental demonstration of this idea. The scan of pasta made with traditional methods and that of pasta made with futuristic technologies has been conducted in three different Italian universities. The studies show how the different types of pasta have a different microscopic structure. **Figure 1** shows a pasta made with durum wheat semolina, produced with standard techniques. It clearly

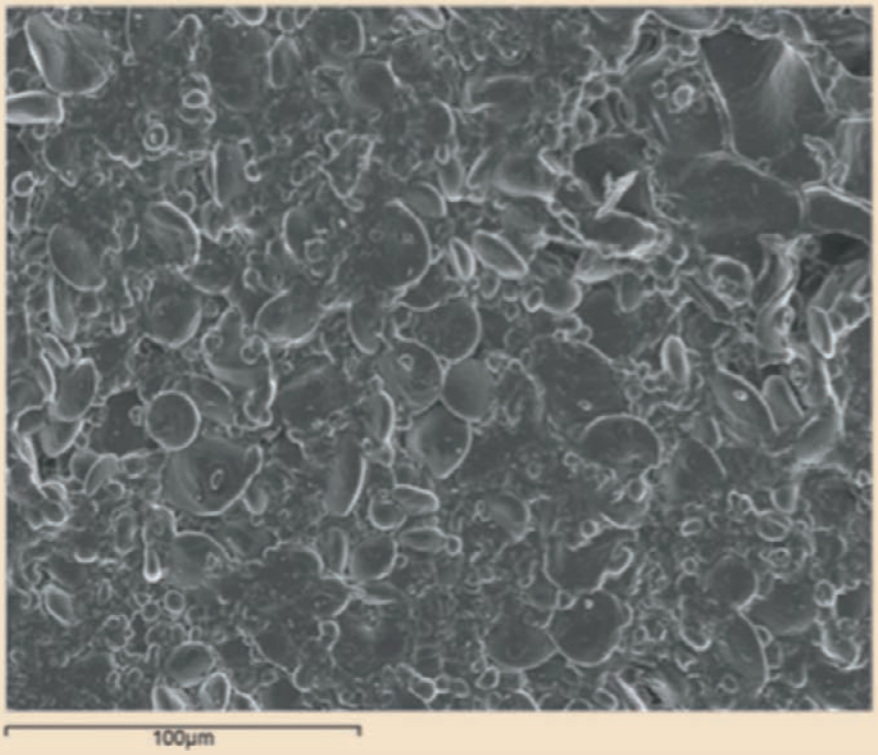

Figure 1
Scanning electron microscopy (100 µ marker) of durum wheat semolina treated with conventional processes (*University of Parma*)

[4] The Greek word for starch is α–μψλοσ that literally means "without mill"; starch in fact is formed after the maceration of unground wheat.
[5] http://www.foodaccademia.it/it/portfolio/pietro-massi/
[6] https://scholar.google.com/scholar?hl=it&as_sdt=0%2C5&q=%22Pietro+Massi%22&btnG=

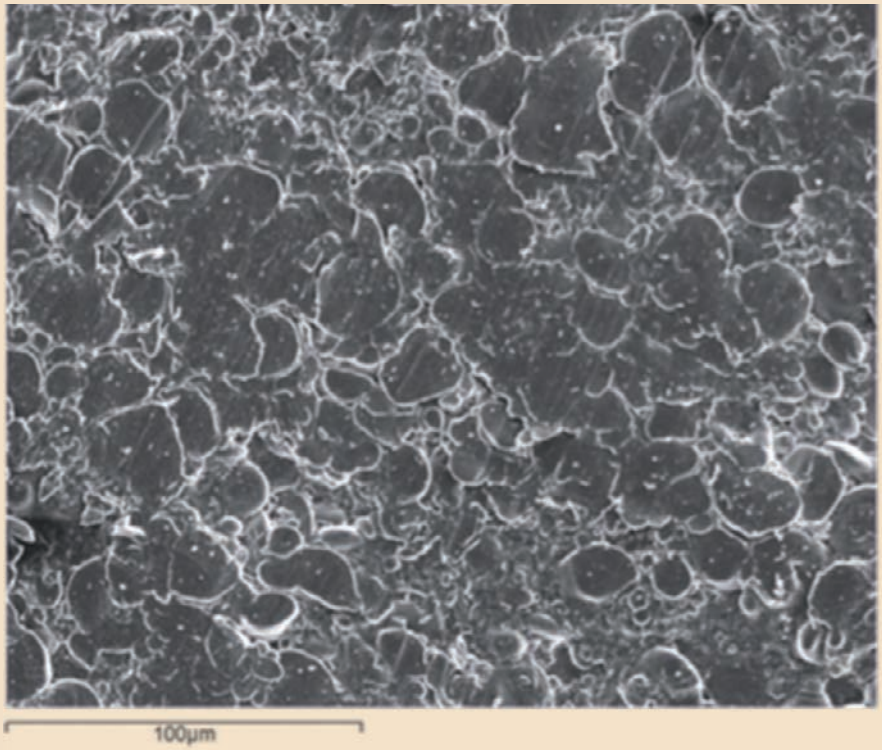

Figure 2
Scanning electron microscopy (100 µ marker) of durum wheat semolina treated with conventional procedures

shows the damages on the granules of starch, with granules partially destroyed or fuses together, secondary to compression forces.
In **Figure 2** the damage is even more evident, because of an improper rolling phase: in this example the structure of pasta is almost completely subverted; there is no integrity of the granules of starch; they merge into indistinct masses, losing the characteristic quaternary structure.
Figure 3 shows another kind of structural alteration: it highlights micro-fractures that appear on the flat surface, without the presence of micro-cavities and canaliculi that permit the correct hydration of the pasta. In this example, the gliadinic component and the regularity of the starch granules cannot be detected.
The characteristics of the final mixture (starch and protein component) and in particular its rheological characteristics of viscosity, elasticity, toughness, etc. depend on the protein structure of gluten and on how it covers and contains the individual starch granules, which, as mentioned above, must be perfectly intact. As a matter of fact, correcting all the processing phases you can obtain an almost perfect pasta. **Figure 4** refers to a Pasta Pietro Massi obtained with patented technologies (durum wheat semolina pasta and egg).

When the microstructure of the pasta is intact, the molecules are better presented to digestive enzymes

The structure of the granules of starch is almost perfect: they are intact and coated and immersed in the glutinous protein component. That forms bridges and integral interconnections that support the whole structure. The micro-cavities that allow the passage of water are present. No part of the surface is smooth, compressed or flattened. Similarly, **Figure 5** shows the structure of a

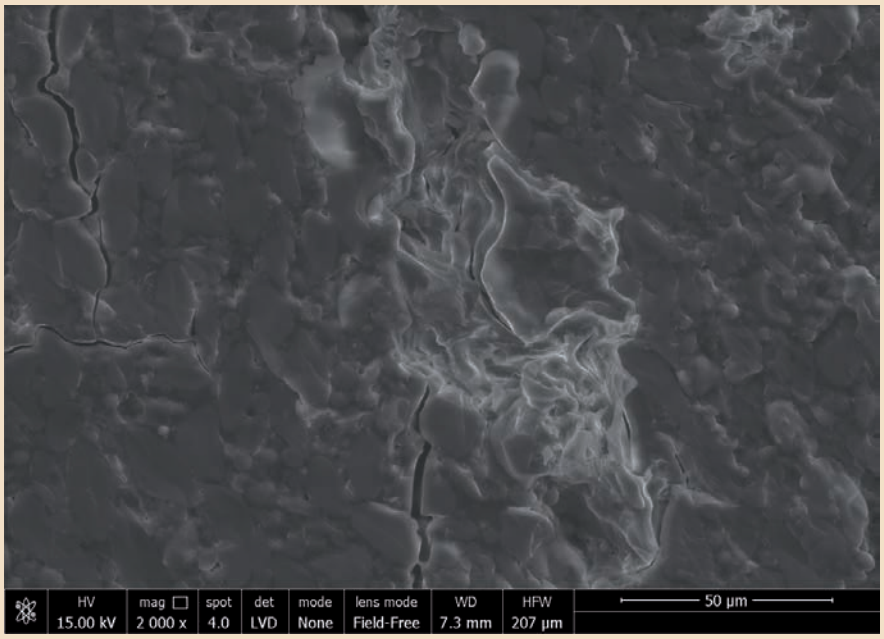

Figure 3
Scanning electron microscopy (2000 linear markers at 50 µ) of durum wheat semolina pasta treated with conventional technologies, with low-temperature drying and slow-processing certification (*University of Modena and Reggio Emilia; courtesy of Italiana Pastifici*)

durum wheat semolina pasta processed during the whole production with Pasta Pietro Massi's machines and technologies: the starches are perfectly intact; there are cavities for the passage of water, but there are no fractures coming from the working process; the surface is widely wrinkled and not flat; the protein component that binds the granules of starch is very well outlined. In both photos of pasta produced with these innovative technology (4 and 5), the granules of starch are perfectly evident; those are perfectly shaped and most of them are protected by the protein matrix assuming three-dimensional plasticity.

The production processes should not do violence on the dough

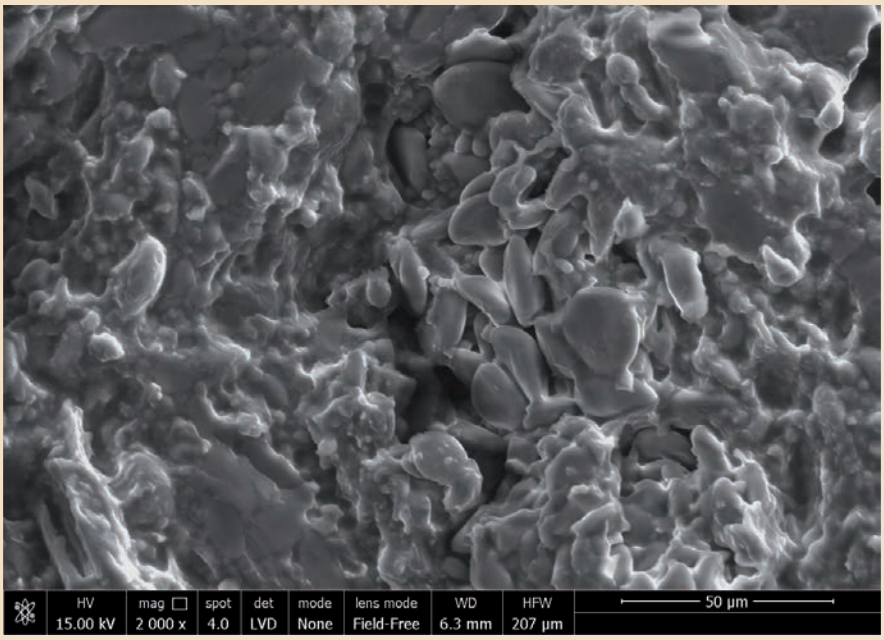

Figure 4
Scanning electron microscopy of durum wheat semolina pasta (CWAD) and egg treated with Pietro Massi technologies (2000 linear markers at 50 µ (*University of Modena and Reggio Emilia; courtesy of Italiana Pastifici*)

Based on our experience we believe that the ultrastructural characteristics found in the different type of pasta can influence the chemical-physical characteristics of the dough (as elasticity, viscosity, mellowness, etc.); that consequently produce valuable effects on the physiology of digestion and therefore on health.

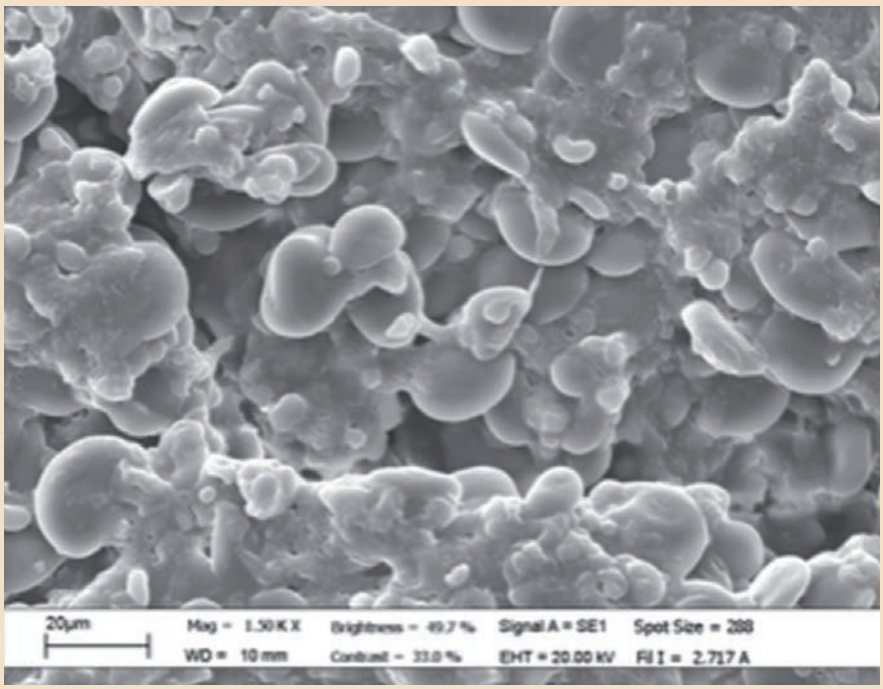

Figure 5
Scanning electron microscopy of durum wheat semolina pasta treated with Pietro Massi technology (long pasta rolled at 0.8 with LAR 350, 1500 linear marker at 20 µ (*University of Rome "La Sapienza" - courtesy of Italiana Pastifici*)

Wellness at the table

In fact, in extreme synthesis, the pasta's ultrastructure influences the loss in the cooking water of important components, and play a role in "how" the food is presented to and processed by the human body. When the microstructure of the pasta is intact, the molecules are better presented to those digestive enzymes (like ptyalin and pepsin) that treat the food so to properly extract nutrients. The structure permits the exposure of proteo-glucid macromolecules on the taste buds improving also the taste. The sense of satiety is also positively affected. Moreover, the progressive and slower demolition of starches has a positive effect on blood glucose level and on insulin resistance. A quality pasta has a better glycaemic index (GI) than other carbohydrate-based foods like bread or potatoes (10); we

believe that a pasta with these structural characteristics may results in even better IG values. This has important effect on human health as it reduces the hyper-insulin stress that happen when the assimilation of sugars is too fast or whenever there is a glycaemic peak.
In conclusion, pasta is one of the most eaten food in the world; its market is expanding. The consumption of this unbroken starch floating into a gliadin matrix (namely the pasta) strongly affects our health. Governments across Europe are asking industries to provide healthy products for everyone. However, to achieve appreciable results on human health, food must be tasty and appealing. Otherwise, people simply will not eat it. The time of restrictive-but-healthy diets versus spontaneous nutritional patterns has come to an end. Pasta, in fact, can be tasty and healthy at the same time: this is up to us.
The right mix between technology, wellness and health, taste and production of comfort food, took years and the developing of properly designed technologies. Yet, we achieved it. Therefore, yes, the mission is possible.

Antonio V. Gaddi

References

Sicignano A, Di Monaco R, Masi P, Cavella S. From raw material to dish: pasta quality step by step. Journal of the science of food and agriculture. 2015;95(13):2579-87.

Di Bello A. The drying phase and the qyality of pasta. Professional Pasta. 2019;3:12-20.

Cecchi L, Schuster N, Flynn D, Bechtel R, Bellumori M, Innocenti M, et al. Sensory Profiling and Consumer Acceptance of Pasta, Bread, and Granola Bar Fortified with Dried Olive Pomace (Pate): A Byproduct from Virgin Olive Oil Production. Journal of food science. 2019.

Pasqualone A, Gambacorta G, Summo C, Caponio F, Di Miceli G, Flagella Z, et al. Functional, textural and sensory properties of dry pasta supplemented with lyophilized tomato matrix or with durum wheat bran extracts produced by supercritical carbon dioxide or ultrasound. Food chemistry. 2016;213:545-53.

Kowalczewski P, Lewandowicz G, Makowska A, Knoll I, Blaszczak W, Bialas W, et al. Pasta Fortified with Potato Juice: Structure, Quality, and Consumer Acceptance. Journal of food science. 2015;80(6):S1377-82.

6 Martinez CS, Ribotta PD, Anon MC, Leon AE. Effect of amaranth flour (Amaranthus mantegazzianus) on the technological and sensory quality of bread wheat pasta. Food science and technology international = Ciencia y tecnologia de los alimentos internacional. 2014;20(2):127-35.

Rasheed F, Newson WR, Plivelic TS, Kuktaite R, Hedenqvist MS, Gallstedt M, et al. Macromolecular changes and nano-structural arrangements in gliadin and glutenin films upon chemical modification: Relation to functionality. International journal of biological macromolecules. 2015;79:151-9.

Rasheed F, Plivelic TS, Kuktaite R, Hedenqvist MS, Johansson E. Unraveling the Structural Puzzle of the Giant Glutenin Polymer-An Interplay between Protein Polymerization, Nanomorphology, and Functional Properties in Bioplastic Films. ACS Omega. 2018;3(5):5584-92.

Khatkar BS, Barak S, Mudgil D. Effects of gliadin addition on the rheological, microscopic and thermal characteristics of wheat gluten. International journal of biological macromolecules. 2013;53:38-41.

Huang M, Li J, Ha MA, Riccardi G, Liu S. A systematic review on the relations between pasta consumption and cardio-metabolic risk factors. Nutrition, metabolism, and cardiovascular diseases : NMCD. 2017;27(11):939-48.