THE INTERNATIONAL MAGAZINE FOR PASTA PRODUCERS

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Drying pasta at low temperature

Ukraine, the grain market

Tariffe R.O.C. Poste Italiane - Spedizione in abbonamento postale - D.L. 353/2003 (cov.in L. 27/02/04 n°46) Art. 1 comma 1 DCB Bologna

N. 1 January/ March 2016

Avenue media®

Year XXI

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The results of a study by the University of Florence (Italy) in collaboration with Fabbri Artisan Pasta, known for the excellence of its products



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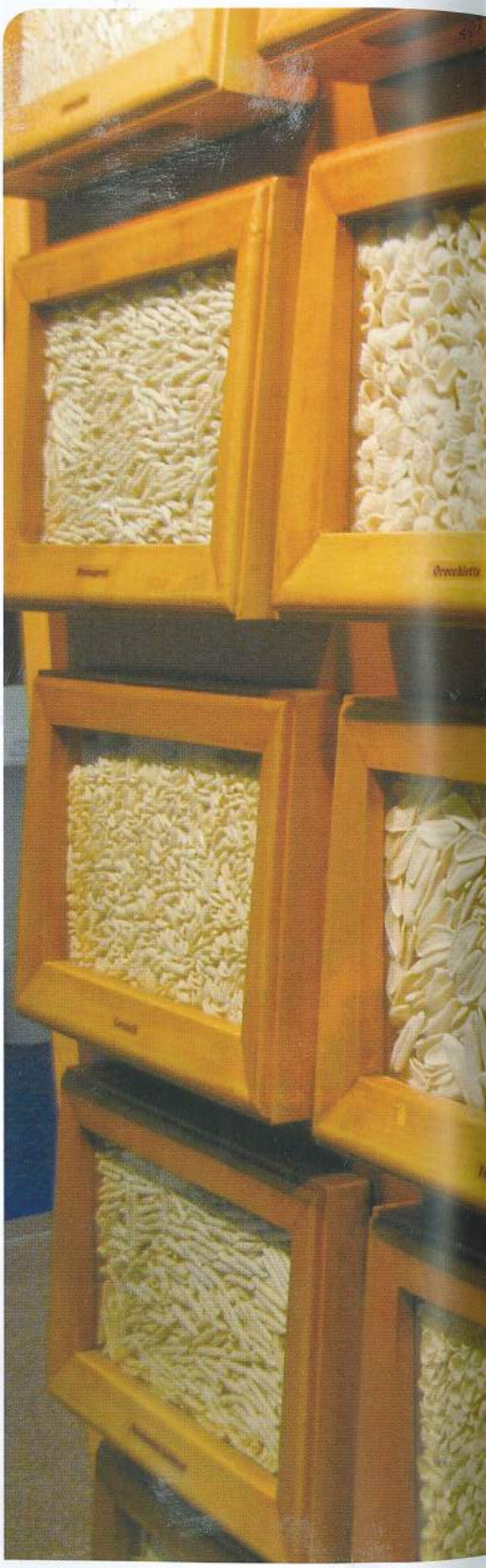


Pasta drying in air flow is a complex phase in the pasta making process. Traditionally, dehydration temperatures range between 50 and 120° C. However, within the range of methods available, there is also scope for low temperature drying. The study of drying kinetics, which describes the change in water content of the product over time, as well as factors influencing this process, is useful in order to understand the necessary times and methodologies required. In the following article, we publish the results of a study conducted in collaboration with the artisan pasta-making factory owned by Fabbri, who made available the premises for the analysis of drying kinetics under low-temperature airflow.

The Editing Staff

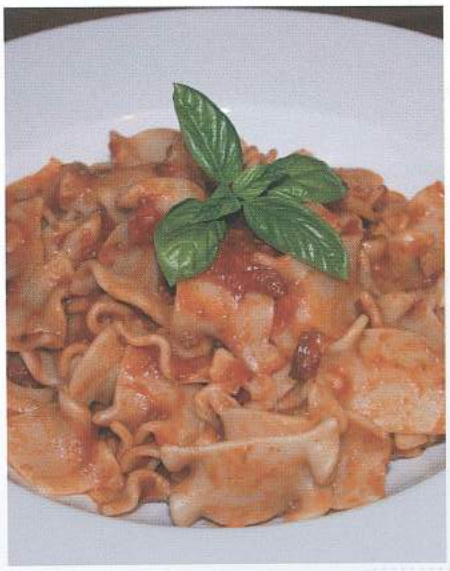
One of the fundamental and critical control points in the dried pasta production is the drying process in air flow (Zanoni, 2006). Depending on the dry bulb temperature of the hot air used, three modes of drying are generally used (Kill and Turnbull, 2008):

- low temperature drying (LT): temperatures of 50-55° C for 14-20 hours;
- hight temperature drying (HT): temperatures of approximately 75° C for 7-10 hours;
- ultra hight temperature drying (UHT): temperatures of 80-120° C for a few hours.

mperature in air flow

«Low temperature drying means 50-55° C for 14-20 hours»

However, there are less-studied cases of very low temperature (around 30° C) drying, over a long time duration, in the order of days. The aim of the present research is to build the drying kinetics during very low-temperature drying and understand the phenomenology.
The study was conducted in the Fabbri artisan pasta factory at Greve in Chianti (Florence, Italy). The production process included the kneading (mixing) of semolina with water under vacuum for about 25 minutes. Thereafter, the dough was extruded, cut into shapes,



and the pasta pre-dried in a discontinuous dryer. The short pasta shapes were pre-dried using a tower dryer, whilst longer shapes were pre-dried in a tunnel dryer. The pre-drying air temperature was 33-35 °C and relative humidity, approximately 85%.
Pre-drying times ranged between 25-30 minutes for the short pasta formats and 60 minutes for long pasta format. Pre-drying resulted in a 4-6% moisture content reduction from the respective initial values after extrusion. The pasta

«Short pasta shapes were pre-dried using a tower dryer»

was subsequently transferred to a discontinuous dryer cabinet, operating with an air flow set at 30 °C. The drying times were 3-4 days and 5-6 days for the short and long pasta shapes, respectively. The above mentioned time periods included a period of one day, required for the stabilization and cooling phases. The dried pasta was then sent for packaging. In the present research, four different pasta shapes were

«Measurements were compared for each format»

were analyzed, one long and three short, which the factory classified as "spaghetti", "penne-rigate","casarecce", and "stracci", respectively. For each drying treatment, temperature and relative humidity were monitored. For the kinetics drying study, a sample of 500 grams of moist pasta (freshly extruded) was used for each type of pasta shape. The initial moisture content was measured gravimetrically with drying in an oven at 100° C for about three days. The pasta samples then underwent the respective pre-drying and drying phases, during which samples were periodically taken and weighed to determine

Pre-drying of spaghetti in tunnel pre dryer

moisture content. The first sampling was performed at the end of the pre-drying phase, after which sampling was undertaken every four hours during the drying phase. Taking into account the decrease in pasta weight, humidity values were calculated using a spreadsheet, from which the absolute humidity values and the speed of drying were calculated. From the data, it was possible to build kinetic drying diagrams for each type of pasta. A sample of dried pasta was taken after the drying period and it was measured final moisture to validate the calculed data of drying kinetics.

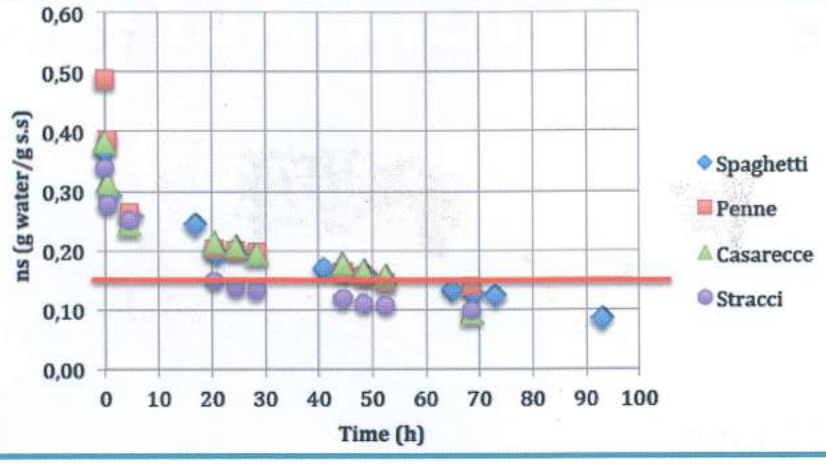
The drying kinetics

The figures show the characteristic diagrams, describing the drying kinetics of the pasta in air flow as follows:

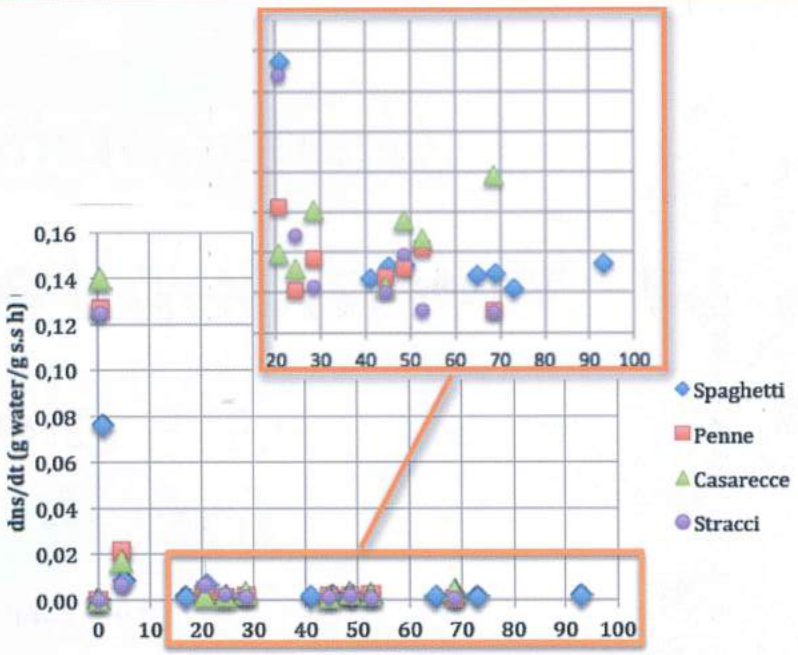
- change in time of absolute humidity (water content per unit mass of dry matter) (GRAPH 1);
- change in time drying rate over time (absolute humidity variation per unit of time) (GRAPH 2);
- variation in drying rate in function of the decrease in absolute humidity (GRAPH 3).

In order to compare the drying performance of the different pasta shapes, the measurements were calculated and compared for each individual format. The general trend of drying kinetics for the different formats was similar, and was related to the classic drying curves for solid food (Zanoni, 2006). It has prevailed thus the drying step to trend slowed down, which in these cases was particularly prolonged for the low-temperature of air drying.
The steps of heating and constant trend to have ended in the first hour of processing, corresponding to the duration of the pre-drying. It was noted that there were differences in drying according to pasta shape.

GRAPH 1 Variation in absolute humidity in function of time



GRAPH 2 Variation in the speed of drying in function of time



GRAPH 3 Variation in the speed of drying in function of absolute humidity

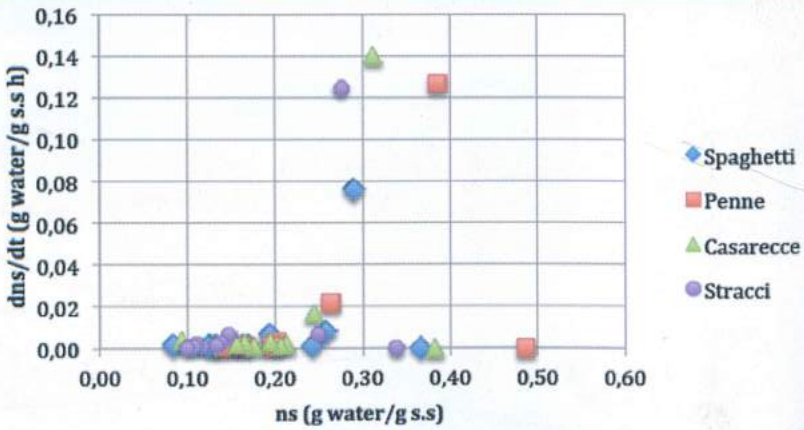


TABLE Values of the average rate of pre-drying of the various pasta shapes

SHAPES	SPEED OF PRE-DRYING *(g water/g s. sh)*
Spaghetti	0,08
Penne	0,13
Caserecce	0,14
Stracci	0,12

Extrusion of spaghetti

Fabbri Artisan Pasta uses low temperature drying method to obtain its excellent products

In the pre-drying phase, the drying speed of spaghetti was less than that for the short formats (Table). This was suggested to be attributable to greater relative humidity of the air during the tests conducted on spaghetti, a significant effect when combined with the low drying temperature. During the drying phase, it was also noted that the "spaghetti", "penne" and "casarecce" reached the desired final moisture value, below the legal limit of 12.5% (indicated by the red line), after about 70 hours of drying. The "stracci" attained this value in less time (about 30 hours). The faster dehydration of the "stracci" in comparison to the other formats was suggested to be attributable both to the greater surface area exposed to the heat and the reduced thickness of the format. Support for this can be seen in Figure 1. (b), where the "stracci" showed an increased drying speed in function of time.

Low-temperature pasta drying followed the general theory for drying of solid food. In this specific case the phases of heating and constant trend

«Drying kinetics were similar for different formats»


Spaghetti drying in the dryer cabinet

coincide with the pre-drying, while the drying step was entirely trend slowed. From an operational point of view the interpretation of the kinetics makes possible the prediction of the necessary time required to reach the legal moisture limit. This type of methodology may be useful in designing drying regimes taking into account product quality and processing costs. ■

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ACKNOWLEDGMENTS

The authors wish to thank the Fabbri Artisan Pasta factory for its cooperation in the research

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