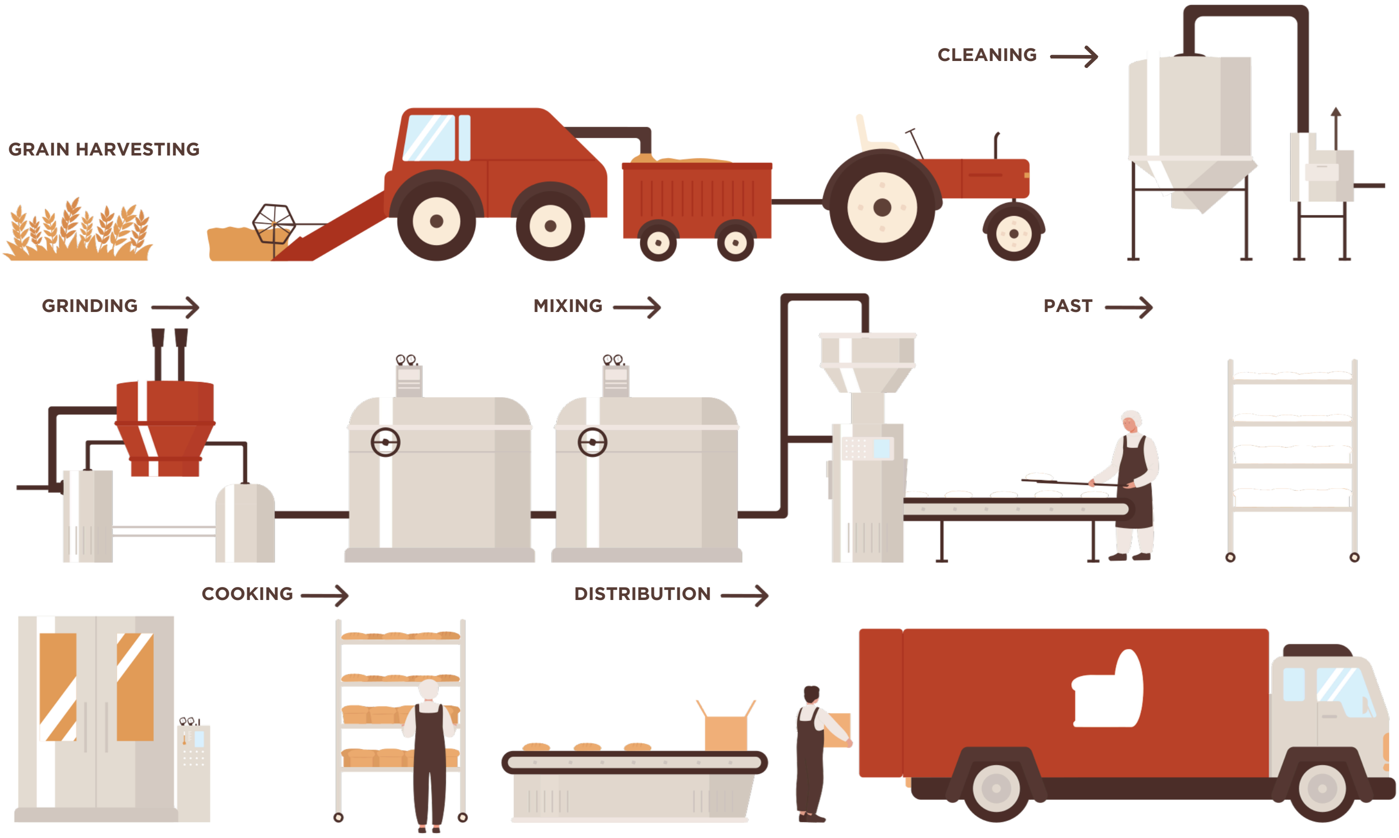
THERMOREGULATION OF PASTES

THE USE OF CARBON SNOW TO FACILITATE PRODUCTION PROCESSES

Dough thermoregulation is especially useful in large industrial settings with production processes related to the baking, white art and confectionery industries



The advantages of thermoregulation

SIAD's proposal for timely temperature control during the mixing stages is the use of carbonic snow, a -78-degree solid product obtained from the expansion of CO_2 liquid, capable of rapidly and effectively lowering the temperature. In contrast to traditional water-based ice, carbonic snow has the advantage of not releasing moisture, avoiding changing the composition of the dough.

In fact, carbonic snow, or dry ice, changes from a solid to a gaseous state without diluting in water, protecting the final composition of recipes. **In the bakery sector, the SIAD's product ensures process and quality advantages, with optimization of the flour processing, as well as standardization of quality throughout the year, in fact ensuring a constant processing temperature at all times.** Leavening, during the dough phases, is blocked and the product comes out more malleable and characterized by a greater alvezed by greater alveolation and with more volume for the same weight

Study of the effects related to the use of carbonic snow on the thermoregulation and rheology of doughs

The University of Florence sponsored an experiment in late 2019 that mes- sured the effects related to the potential of using carbonic snow in the bakery sector. In detail, **effects related to production, processing, and standardization processes related to bakery products were tested, with particular attention directed toward industrial bakery.**

Effects of carbonic snow addition on thermoregulation of doughs produced in Chopin alveograph tests

The results on the evolution of dough temperature during the alveographic tests are shown in **Fig. 1a** (Ancient Verna wheat cultivar) and **Fig. 1b** (Modern Bologna wheat cultivar).

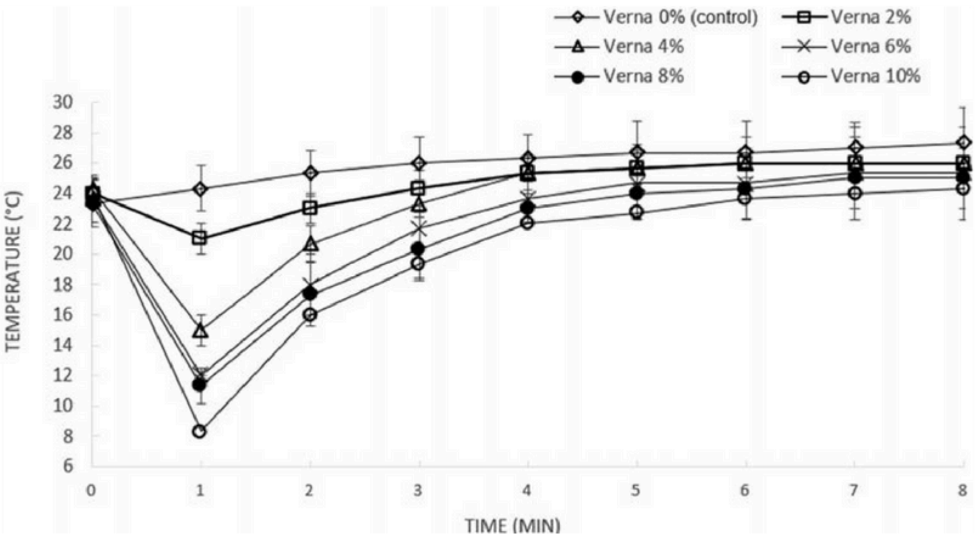


Fig. 1a - Temperatures of the dough made with Verna flour during the kneading process in the Chopin alveographic tests. Data points represent the average of the three replicates ±SD

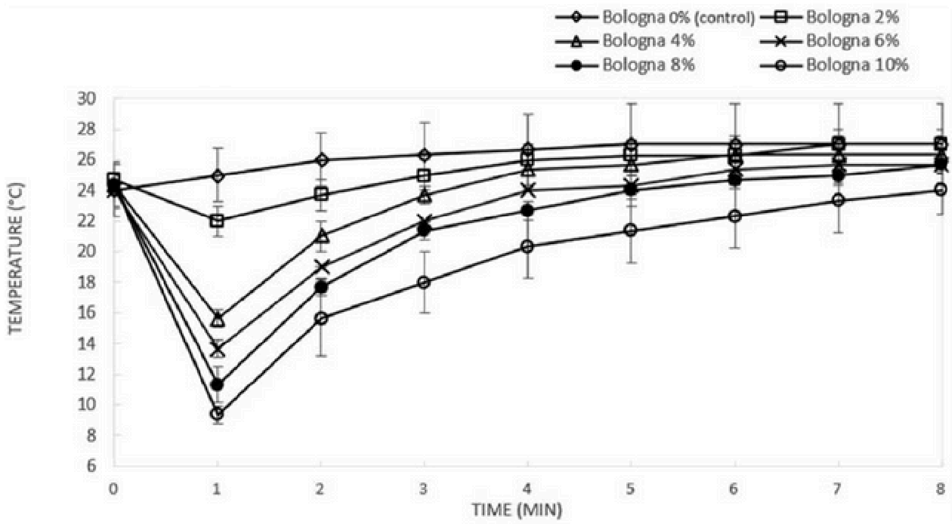


Fig. 1b - Dough temperatures produced with Bologna flour during the kneading process in Chopin's alveographic tests. Data points represent the average of the three replicates ±SD

As observable in Figures 1a and 1b, the results show that after 8 minutes of kneading, the final dough temperature increased by 3°C and 4°C (for the two grain ti- pologies ancient and modern, respectively) in the case of the control (which does not include the addition of carbonic snow). **In contrast, in the case of carbonic snow addition, the lowering of tempera- ture recorded during the Chopin alveograph tests was greater than 1°C per percent degree of carbonic snow added.**

More in detail, the dough undergoes a significant temperature lowering (at 1 minute, corresponding to the time of carbonic snow addition), followed by a re- penting temperature rise, related to kneading.

Effects of carbonic snow addition on thermoregulation of doughs produced in baking trials

The results for the evolution of dough temperature during bread-making trials are shown in **Fig. 2a** (Cultivar of ancient Verna wheat) and **Fig. 2b** (Cultivar of modern Bologna wheat).

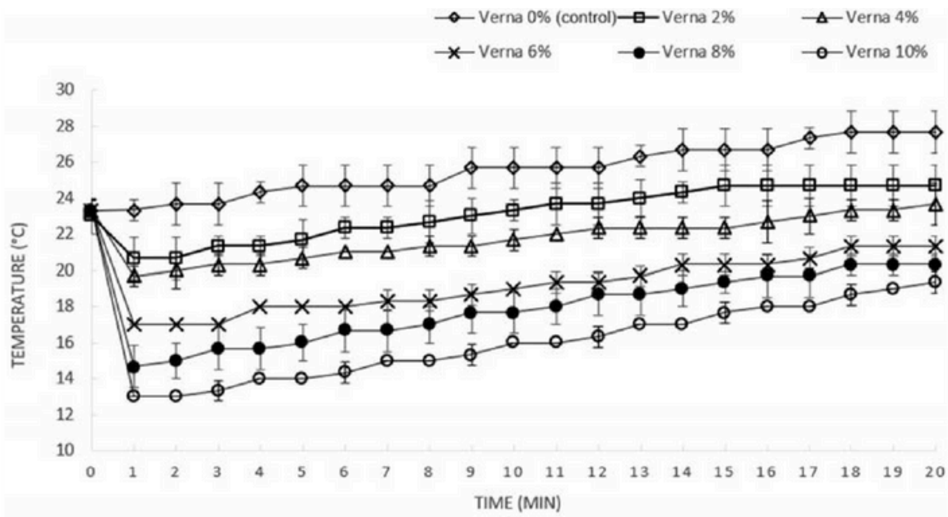


Fig. 2a - Temperatures of doughs made with Verna flour during the kneading process in the baking trials. Data points represent the average of the three replicates ±SD.

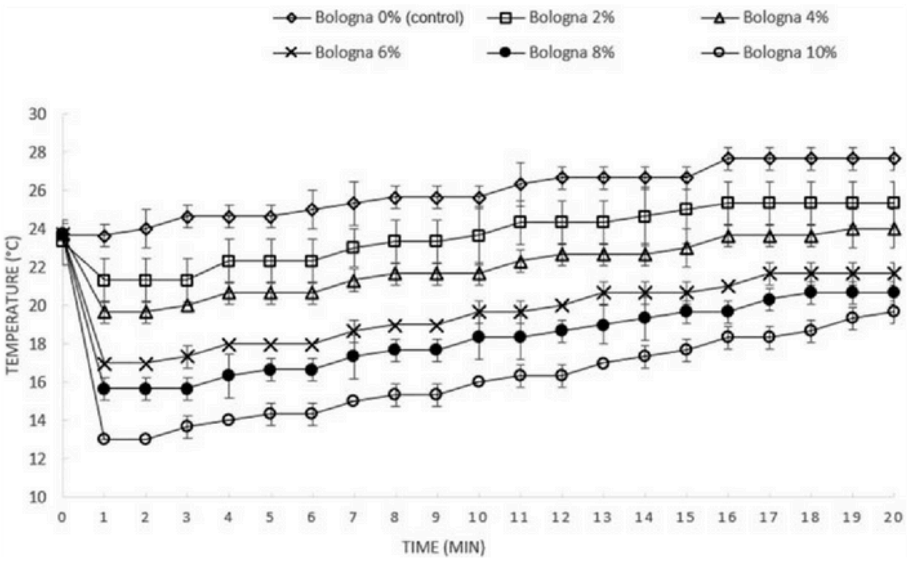


Fig. 2b - Temperatures of doughs made with Bologna flour during the kneading process in the breadmaking trials. Data points represent the average of the three replicates ±SD

As observable in Figure 2a and 2b, the results show that after 20 minutes of kneading, the final dough temperature increased by 4°C (in both cultivars) in the case of the control (which does not include the addition of carbonic snow). **The temperature drop recorded during the breadmaking trials was 1°C per percent degree of carbonic snow added.**

Notably, during the breadmaking trials, the dough undergoes a less abrupt temperature lowering, followed by a reduced, but mostly progressive and less abrupt, temperature rise due to kneading in a closed system with limited external exchange.

Dough reaction tests

Sample	P (Dough tenacity)	L (Dough extensibility)	G (Index of swelling)	W (Deformation energy)	P/L
Bologna 0% (control)	114.47 ± 11.05	40.73 ± 10.83	14.11 ± 1.83	195.40 ± 29.30	3.00 ± 0.87
Bologna 2%	112.93 ± 11.94	38.33 ± 2.77	13.77 ± 0.48	193.47 ± 18.25	2.98 ± 0.39
Bologna 4%	113.40 ± 9.30	37.53 ± 5.46	13.61 ± 0.98	187.93 ± 29.41	3.08 ± 0.42
Bologna 6%	111.47 ± 6.80	37.80 ± 4.81	13.67 ± 0.86	184.93 ± 20.04	3.01 ± 0.46
Bologna 8%	113.80 ± 8.14	38.60 ± 3.62	13.11 ± 0.66	184.07 ± 17.57	3.13 ± 0.56
Bologna 10%	113.80 ± 9.26	39.20 ± 0.87	13.93 ± 0.15	195.20 ± 15.46	2.93 ± 0.21
Verna 0% (control)	26.40 ± 1.74	29.20 ± 3.98	12.02 ± 0.81	26.53 ± 4.00	0.92 ± 0.09
Verna 2%	28.87 ± 2.84	30.07 ± 0.50	12.21 ± 0.09	29.47 ± 3.11	0.97 ± 0.09
Verna 4%	28.07 ± 1.81	30.60 ± 2.62	12.30 ± 0.52	28.67 ± 1.55	0.94 ± 0.13
Verna 6%	30.93 ± 4.12	33.53 ± 6.29	12.85 ± 1.17	33.27 ± 7.83	0.95 ± 0.10
Verna 8%	30.47 ± 2.05	33.33 ± 5.43	12.79 ± 0.98	31.67 ± 5.26	0.92 ± 0.12
Verna 10%	29.80 ± 3.47	33.93 ± 4.69	12.93 ± 0.90	32.07 ± 1.92	0.91 ± 0.21

Table 1 - Results of the alveographic tests (average of five measurements - diskettes - for each test) expressed as the average of the three replications ± SD

Sample	Bread specific volume (L/kg)	Crumb density (g/ml)	Loaf height (mm)	Crumb moisture (%)	Crust moisture (%)
Bologna 0% (control)	2.47 ± 0.05^{a}	0.361 ± 0.03	76.37 ± 2.49^{a}	42.87 ± 0.23	24.84 ± 0.51
Bologna 2%	2.56 ± 0.10^{ab}	0.342 ± 0.01	79.70 ± 2.87^{ab}	42.69 ± 0.18	24.92 ± 1.62
Bologna 4%	2.63 ± 0.15^{ab}	0.353 ± 0.03	81.10 ± 3.32^{b}	42.94 ± 0.58	25.52 ± 1.36
Bologna 6%	2.71 ± 0.06^{b}	0.344 ± 0.04	84.90 ± 2.31^{bc}	42.87 ± 0.33	25.52 ± 1.64
Bologna 8%	2.72 ± 0.13^{b}	0.315 ± 0.01	87.47 ± 1.34^{c}	42.60 ± 0.51	25.50 ± 0.56
Bologna 10%	2.73 ± 0.09^{b}	0.328 ± 0.01	87.07 ± 2.00^{c}	42.71 ± 0.17	24.17 ± 0.85
Verna 0% (control)	2.48 ± 0.13^{a}	0.351 ± 0.05	64.87 ± 0.46^{a}	39.98 ± 1.39	25.47 ± 2.73
Verna 2%	2.52 ± 0.20^{a}	0.374 ± 0.06	69.90 ± 1.39^{b}	40.72 ± 0.85	25.29 ± 0.79
Verna 4%	2.70 ± 0.17^{ab}	0.355 ± 0.03	71.03 ± 0.29^{bc}	40.97 ± 0.61	24.46 ± 0.74
Verna 6%	2.78 ± 0.17^{b}	0.320 ± 0.03	71.93 ± 0.91^{bc}	40.49 ± 0.82	24.09 ± 1.13
Verna 8%	2.88 ± 0.10^{b}	0.333 ± 0.03	72.27 ± 0.87^{c}	40.35 ± 0.48	23.66 ± 1.17
Verna 10%	2.89 ± 0.10^{b}	0.335 ± 0.04	73.20 ± 1.44^{c}	40.42 ± 0.52	24.05 ± 1.18

Table 2 - Bread characterization results and p-values evaluated by one-way ANOVA. Results are expressed as mean of the three replicates ± SD. (-) indicates no significant difference at $p < 0.05$

The experimental results confirm the **great potential of using carbonic snow in the baking industry.** In particular, the powerful thermoregulation effect of doughs during the baking process was clearly confirmed. The addition of high concentrations of carbonic snow (8 and 10%) slightly improved the rheological performance of doughs obtained from the ancient wheat cultivar Verna, which proved to be very difficult to process.

Instead, the results of statistical analysis show a statistically significant effect on specific volume and central height of bread (in particular, specific volume of bread should be considered as one of the most important physical parameters of bread).

The addition of high concentrations of carbonic snow (from 6 to 10 percent) is recommended, increasing able to improve the performance of bread from ancient and modern grains, significantly **increasing the specific volume and central height of bread and slightly reducing the crumb density.**

The advantages of using carbonic snow:

- **Ease of application (compared to other refrigerants)**
- **No increase in total water content**
- **No chemical or toxic residues**

Conclusions and future prospects

The high variety of products and the continuous search for innovation in productive processes make SIAD a company in step with the times and evolutionary processes, always ready to respond to the needs of partner companies with new solutions and with an eye to the issues of sustainability and food safety.

Packaging, freezing, and temperature control are the three applications involved. Further interesting point concerns the regulations on the term "fresh bread": in fact, bread prepared according to a continuous production process, with no interruptions aimed at freezing or deep-freezing except for the ral- lentation of the leavening process, free of preservative additives and other treatments having a preservative effect, is called "fresh." **Thus, freezing/cooling in use for the purpose of slowing down the leavening process consequently represents an inte- ressing aspect to be investigated.**

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