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RESEARCH LETTER

Glycaemic response to pasta from three different wheat varieties in individuals with type 2 diabetes

Ilaria Dicembrini MD[1] | Giuseppe Cavallo PhD[2] | Francesco Ranaldi MD[1] | Daniele Scoccimarro MD[1] | Chiara Caiulo MD[1] | Giovanni A. Silverii MD[1] | Paolo Iovino PhD[2] | Camilla E. Magi PhD[2] | Guglielmo Bonaccorsi MD[2] | Laura Rasero PhD[2] | Edoardo Mannucci MD[1]

[1]Experimental Clinical Biomedical Sciences 'Mario Serio' Department, University of Florence, Florence, Italy

[2]Department of Health Sciences, University of Florence, Florence, Italy

Correspondence
Ilaria Dicembrini, Experimental Clinical Biomedical Sciences 'Mario Serio' Department, University of Florence, Florence, Italy.
Email: ilaria.dicembrini@unifi.it

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1 | BACKGROUND

Over the last 50 years, new varieties of durum wheat (*Triticum turgidum* spp. *durum*), used for the production of pasta, have largely replaced more traditional varieties because of their higher productivity. Apart from differences in organoleptic properties of products obtained from different wheat varieties, the older varieties, also known as 'ancient grains', have been associated with possible benefits for human health, including a smaller increase of post-prandial glycaemia.[1–4] Preliminary studies suggested that the absorption of pasta and bread from ancient grains could be slower than that of their counterparts from modern grains, determining a lower glycaemic index (4).

The preference for carbohydrate-containing foods with lower glycaemic index (e.g. beans, pasta, whole-grain bread) and the limitation in the consumption of foods at high glycaemic index (e.g. rice, sugar) are recommended for the improvement of glycaemic control in type 2 diabetes.[5–7] However, the glycaemic index of some foods (e.g. pasta) could be different depending on the variety of wheat used for their production (4). The present study is aimed at assessing the differential effect on post-prandial glucose of pasta produced with different varieties of durum wheat.

2 | METHODS

This double-blind, randomised, cross-over trial (Florence Ethical Board approval number 15425_spe) was performed on adults with type 2 diabetes, with HbA1c < 58 mmol/mol. Patients treated with anti-hyperglycaemic drugs other than metformin were excluded, as well as those receiving corticosteroids. After providing written informed consent, each participant was randomised (using a computer-generated randomisation list) to perform a meal test on three different days (days 1, 3, 5), using pasta from the three wheat varieties in different order, to test potential differences on the acute glycaemic response from one modern (Claudio) and two ancient (Khorasan and Senatore Cappelli) wheat varieties, all of certified organic origin. Claudio and Khorasan were produced by Guazzini farm (Massa Marittima, Grosseto, Italy), whereas Senatore Cappelli was produced by Il Felciaione (Suvereto, Livorno, Italy). The pasta from Claudio, Khorasan and Senatore Cappelli was produced by Valle Bruna (Pistoia, Italy), Guazzini

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(Massa Marittima, Grosseto, Italy) and PROSIT (Fontanelle, Pisa, Italy) respectively. Pasta from the three varieties, in the shape of 'penne rigate' number 20, was indistinguishable. During the study, apart from the standardised pasta meal described above and at least 4 h of fasting before, patients were asked to follow their usual diet.

The macronutrient composition of samples of pasta from three varieties was performed by a UNI CEI EN ISO/IEC 17025 accredited laboratory (Analytical food). Protein and fat compositions were determined following the analytical methods reported for food chemical control by local health authorities, the ISTISAN 1996/34 standard,[8] whereas fibres were measured using the Association of Official Agricultural Chemists 985.29 standard.[9] Carbohydrates were calculated as the difference between total weight and that of other nutrients and ashes.[10]

Each pasta sample was cooked for 8 min in boiling water and served in 70 g portions with a dressing of 50 g of tomato purée and 7 g of extra virgin olive oil. Only the investigator in charge of meal preparation was aware of the type of pasta served on any single day of the trial. All other investigators and the study participants were blinded to the wheat variety used on each study day. Participants were asked to remain at rest, on the study site, refraining from smoking, physical activity and further food ingestion, for 180 min after the beginning of each meal.

Interstitial glucose was monitored through a glucose sensor (Freestyle Libre, Abbott), applied 48 h before the day 1: glucose levels at baseline, 30, 60, 90, 120, 150 and 180 min, and 60- and 180-min incremental area under the curve (iAUC) calculated on the basis of measurements performed every 5 min, were compared between Claudio, Khorasan and Senatore Cappelli, using univariate repeated measures ANOVA test, performed on SPSS® 27.

TABLE 1 Results of macronutrient composition analysis of the three varieties of pasta (Senatore Cappelli, Khorasan and Claudio).

	Senatore Cappelli	Khorasan	Claudio
Carbohydrates	78.2	79.8	79.7
Proteins	10.1	9.7	9.4
Fat	0.3	0.3	0.2
Fibres	2.5	2.0	2.7

Note: Data are expressed as grams per 100 g.

3 | RESULTS

The macronutrient composition was similar for the three varieties of pasta, irrespective of the wheat variety used for its production (Table 1).

Of the 30 patients enrolled (14 women, 16 men; mean age 62.7 ± 4.5 years, mean body mass index 26.9 ± 2.3 kg/m^2, median HbA1c 46 mmol/mol [38–52]), and diabetes mean duration 4.0 years [1.0–20], 26 were treated with metformin, whereas four did not take diabetes-related drugs. Patients were randomised in three groups, receiving the three varieties in different order (Study Flow of Participants, Supplementary Appendix). Baseline characteristics of the study sample and across the three groups have been reported in the Supplementary Appendix, Table S1. All patients completed the study, and no adverse events were observed.

Mean interstitial glucose levels at different time points, and 60- and 180-min glucose iAUC, are summarised in Table 2. Glucose levels after Claudio were significantly lower than Khorasan at 90 and 120 min, and lower than Khorasan and Senatore Cappelli at 180 min. The 180-min iAUC after Claudio was lower than both Khorasan and Senatore Cappelli, whereas the 60-min iAUC after Claudio was lower than Khorasan, but not Senatore Cappelli. No other significant difference was observed across wheat varieties.

4 | CONCLUSIONS

Individuals with diabetes are often over-exposed to nutritional recommendations, aimed at the improvement of glucose control, which have

TABLE 2 Mean interstitial glucose levels (mg/dL) at different time points, and 60- and 180-min glucose incremental area under the curve (iAUC) for each study meal (Senatore Cappelli, Khorasan and Claudio respectively).

		Senatore Cappelli	Khorasan	Claudio
Mean glucose (mg/dL) at	0 min	93.8 ± 19.0	92.0 ± 18.8	96.4 ± 25.3
	30 min	107.5 ± 24	108.5 ± 25.9	110.5 ± 25.9
	60 min	138.4 ± 34.4	138.3 ± 36.4	133.9 ± 30.1
	90 min	142.4 ± 36.7	146.4 ± 43.4	135.2 ± 36.6*
	120 min	140.1 ± 37.7	143.8 ± 43.3	129.7 ± 33.4**
	150 min	136.1 ± 35.9	134.7 ± 34.7	127.4 ± 33.4
	180 min	133.0 ± 29.5	127.3 ± 31.3	124.5 ± 29.2***
iAUC at	60 min	44.6 ± 26.4	46.8 ± 29	38 ± 25.3†
	180 min	7129 ± 3173	7003 ± 3748	5276 ± 3794‡

Note: Data are expressed as mean ± standard deviation.
*$p = 0.026$ versus Khorasan.
**$p = 0.021$ versus Khorasan.
***$p = 0.029$ versus Senatore Cappelli.
†$p = 0.046$ versus Khorasan.
‡$p = 0.002$ versus Khorasan and $p = 0.025$ versus Senatore Cappelli.

little or no effect on glycaemia.[11] The multiplication of useless prescriptions can confuse patients, paradoxically reducing their adherence to more relevant recommendations.[12] Therefore, it is clinically important to discriminate those recommendations capable of producing actual clinical advantages.

Based on the present results, there is no reason to suppose that the use of ancient wheat varieties, such as Khorasan or Senatore Cappelli, for the production of pasta, could provide any advantage with respect to post-prandial glucose control in individuals with type 2 diabetes. In fact, all the differences observed in post-prandial glycaemic response, although small, were in favour of the 'modern' (commercial) wheat variety Claudio. However, the observed differences in post-prandial glucose after eating the same amount of pasta from different wheat varieties, although statistically significant at some time points, were clinically trivial. At the same time, there is no evidence suggesting that the choice of ancient wheat varieties has detrimental consequences on glucose control. Macronutrient composition also appears to be very similar between modern and ancient wheat varieties.

The results of this study should not be overinterpreted. We assessed glucose response to two specific ancient wheat varieties (Khorasan and Senatore Cappelli), compared to only one modern comparator (Claudio), measuring only glucose and not other potentially informative parameters, such as insulin and C-peptide. We did not include other ancient or modern varieties that could have different characteristics. In addition, this investigation was focused on one specific wheat product, that is, pasta; therefore, other products such as bread or other wheat derivatives might have yielded different results.[13] Furthermore, in the present study, cooking times were maintained in the lower range, in accordance with typical Italian taste ('al dente'); thus, it is possible that a longer cooking time, which increases glycaemic index of pasta,[14] affects differently ancient and modern wheat varieties. In addition, results of this study, assessing only acute effects of one meal with different varieties of pasta, are not necessarily representative of glucose control in patients regularly using different types of pasta for all their meals. On the other hand, food intake out of the test pasta meals during the study could have theoretically affected results; however, this possibility appears to be remote, because the baseline glucose levels (before the meal) were similar across the three different wheat varieties.

Despite these limitations, this study suggests that individuals with type 2 diabetes should feel confident in choosing pasta from different wheat varieties according to organoleptic properties and personal taste, without bothering about trivial differences in their effects on glucose levels.

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CONFLICT OF INTEREST STATEMENT

The authors declare no conflicts of interest.

PEER REVIEW

The peer review history for this article is available at https://www.webofscience.com/api/gateway/wos/peer-review/10.1111/dom.16082.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

ORCID

Ilaria Dicembrini https://orcid.org/0000-0002-8163-7710
Daniele Scoccimarro https://orcid.org/0000-0002-4493-517X
Giovanni A. Silverii https://orcid.org/0000-0002-6695-3213
Edoardo Mannucci https://orcid.org/0000-0001-9759-9408

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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