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Review

Is pizza suitable to type 1 diabetes? A real life identification of best compromise between taste and low glycemic index in patients on insulin pump

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ABSTRACT

Opposed to whole wheat (WWP), traditional pizza (TP) is loved by patients with type 1 diabetes mellitus (T1DM) despite causing hyperglycemia. 50 well-trained T1DM patients had higher glucose levels after TP than after WWP or mixed flour pizza, which however was tasty, digestible and metabolically appropriate to break diet monotony.

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Refined flour (traditional) pizza (TP) is becoming more and more popular worldwide, despite its high glycemic index (GI) and troubles preventing glucose spikes in patients with diabetes mellitus (DM) whatever the chosen insulin dose [1]. Low palatability and gastrointestinal discomfort discouraged low GI (LGI) flour utilization [1,2], so we tested taste/digestibility and 2-, 4-/12-h post meal capillary blood glucose (CBG) with different flour pizzas in 50 well-trained insulin pump using T1DM outpatients on good metabolic control (estimated sample size to yield $p < 0.05$ significance with

power 93.4%) of whom 43% had already tried whole wheat (WW), none LGI, pizzas before. Inclusion/exclusion criteria and main features are reported in [Tables I and II](#), [Supplementary Material \[SM\]](#). Their insulin sensitivity index (ISI) and insulin to carbohydrate (I/CHO) ratio were 38.4 ± 50.0 (range 23.6–62.9) and the 11.8 ± 8.0 (range 6.9–18.5), respectively.

1. Study design

All participants were asked to have three consecutive weekly dinners, each consisting of a starter plus a full pizza made from a 120 g leavened dough ball placed on a layer of either traditional

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(00) or WW or glucomannan (GM) enriched LGI flour pizza (Pizza Dinner 1 [PD1], 2 [PD2] and 3 [PD3], respectively). Table III, SM provides details concerning ingredients chosen to prepare the leavened dough balls of traditional [3], WW [4] and mixed LGI flour [12–17]. An electric oven was used to cook them at a 359–380 °C for 60–90 (preferably 80) seconds. On the advice of experimental team members and two professional cooks aiming at the best possible taste-tradition compromise, 10 g GM were added for Pizza 3 preparation. Each time four different kinds of pizza having specific ingredients – referred to as *Primula*, *Girasole*, *Broccoli plus Sausage*, and *Capricciosa* – were prepared from a 120 g dough ball each (as shown in Table IV, SM), and subjects were given 4 different taste, yet equal weight, slices summing up to one patchwork pizza.

The starter included 100 g “buffalo mozzarella”, 40 g raw ham and 25 g traditional bread, summing up to the same calorie and nutrient composition (see Table V, SM, based on Food Composition Tables published by the Italian National Institute of Food and Nutrition Research) [5].

To be able to strictly evaluate post-prandial glycemic effects of insulin boluses adapted to pre-dinner self-monitoring as obtained through nurse verified Accu-Chek Guide® devices (Roche, Switzerland), participants kept their pre-identified best individual basal insulin dosage stable throughout the study. On PD2 and PD3 they self-adapted insulin dose with respect to PD1. After each dinner they completed a multiple choice internally validated questionnaire (Q) on taste, digestibility, personal abilities and worries about hyperglycemia [4–6] (see Table VI SM). Stored data were transferred to the DM record database (MyStar Connect®) and statistically evaluated at the end of the study. Results were expressed as mean ± SD or % and differences calculated by SPSS/PC + software (IBM SPSS Statistics 2015) through rANOVA or Kruskal–Wallis test plus two-tailed paired Student’s t-test with 95% CI, Mann–Whitney’s *U* test and χ^2 test with Yates correction as needed.

2. Outcomes

As reported in Fig. 1, SM, 80% patients were confident in their own ability to adapt insulin to CHO load correctly but only 15%, albeit well-trained, rated themselves fully capable (score 5). Table VII, SM displays added insulin doses on PD1 (3.5 ± 5.5 IU; range 2–9), PD2 (2.5 ± 2.0 IU; range 1–5, $p < 0.05$ vs PD1) and PD3 (1.8 ± 2.0 IU; range 0.5–4, $p < 0.01$ vs PD1). Q-based evaluation of different pizzas as provided in Fig. 2, SM showed all three dinners to have equal digestibility, despite being PD2 less appreciated than PD3 and PD1 (** $p < 0.01$) and severe hyperglycemia progressively less worrying from PD3 to PD2 ($p < 0.05$) down to PD1 ($p < 0.01$).

Fasting blood glucose was superimposable across dinners, having virtually the same amount of CHO (PD1 = 111 ± 17 g; PD2 = 102 ± 16 g, PD3 = 103 ± 36 g, respectively) but progressively higher fiber content from PD1 (2.4 g) to PD2 (12.0 g, $p < 0.01$) up to PD3 (25.2 g, $p < 0.001$ vs PD2 and PD1) (see Table II, SM).

Fig. 3, SM describes the combined effects of CHO/fiber content and different pre-meal boluses resulting in a significant drop in 2-h glucose ($p < 0.05$) after PD3 vs PD2 and PD1 and in both 4-h ($p < 0.05$) and 12-h ($p < 0.01$) glucose vs PD1. No patients had either gastro-intestinal discomfort or symptomatic/severe hypoglycemia during the 24 h following dinners. As seen in Fig. 4 and Table VII, SM, bolus supplements progressively decreased from PD1 to PD2 down to PD3.

3. Discussion

Pizza napoletana (PN) has a soft and thin texture and represents Italian pizza all over the world [7]. In 1984 its typical

ingredients were defined by UNI 10791:98 according to the *Associazione Verace Pizza Napoletana* [8]. In 2010 it was recognized as Traditional Specialty by the European Union [9] and in 2017 UNESCO declared the art of Naples pizza man Intangible Cultural Heritage of Humanity [8–10]. So, when cooking a special flour pizza, attention should be paid to keep taste as good as that of traditional PN which however, due to its high calorie content, would ask for a marked yet unsuccessful increase in insulin doses causing unwanted weight increase [11–13]. The major limitation of our paper is the small number of well-trained insulin pump users involved which *per se* is not representative of all patients with DM. Nevertheless, our results support the literature on metabolic effects of LGI flours [4,14–17]. Moreover, their real novelty is represented by longer term (12-h) benefits and good patient appreciation of a product resulting from a balanced mix of WW flour, kamut and GM tasting like TP.

4. Conclusions

All of the above encourages us to extend the utilization of this kind of flour to patients with type 2 DM (who have troubles *per se* adapting their oral drug doses to changing CHO load), as well as, to those with specific complications/defects like protein-intake limiting nephropathy or celiac disease.

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Authorship

All authors meet the International Committee of Medical Journal Editors (ICMJE) criteria for authorship, take responsibility for the integrity of the work as a whole, and have given their approval for this version to be published.

Authorship contributions

SG, T D-C and FS designed the study and wrote the paper. All complied with data collection, critically assessed the results, and approved the final text.

VDB, GG, MC, GC, AF, CM, MRI, DO, CL, AV, SV, CR and CA shared and approved the study protocol and, after enrolling patients and providing them with assistance during the tests performed in the pizzeria, took care that patients kept good glucose levels before the three pizza-dinners and monitored their blood sugar during the observation period. Finally, they all critically contributed to the final text. All members of the Study Group contributed to the critical reading of the paper and approved the final version.

Compliance with ethical standards

Ours was a spontaneous, unconditioned study organized and authorized by the Ethics Committee of the Campania University “Luigi Vanvitelli”, Naples, Italy.

Ethical standard

This study was conducted in conformance with good clinical practice standards. The study was led in accordance with the Declaration of Helsinki 1975, as revised in 2008.

Human and animal rights

All followed procedures were in accordance with the ethical standards of the responsible committee on human experimentation (both institutional and national).

Informed consent

Written informed consent was obtained from all participants before enrollment.

Data availability

The datasets analyzed during the current study and referred to in the Supplementary Material are available from the corresponding author on reasonable request.

Declaration of competing interest

The Authors have nothing to declare.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.dsx.2020.03.003>.

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