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HOW to make a mix of low glycemic index flours for a good Neapolitan pizza for patients with diabetes

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ABSTRACT

Background and aims: Our recent data document that a low glycemic index (LGI) Neapolitan pizza prepared with a mix of Kamut and whole wheat flours plus Glucomannan, (i) has a lower impact on postprandial hyperglycemic spikes than pizza made of whole wheat flour, (ii) is pleasant and appreciated as traditional one and (iii) does not cause any gastro-intestinal troubles. The aim of our study was to describe the validation process underlying the identification of the right mix of those elements for a LGI pizza preventing gastro-intestinal disturbances.
Methods: we described all procedures followed to make good products with different combinations of the three components and a series of tests made by four well-experienced professional pasta-making masters, one nutritionist, five diabetologists, one nurse and twenty volunteers with T1DM.
Results: we could identify the best workable and most suitable flour mix to achieve both pleasant taste and low glycemic impact proving to be efficient in real-life twin paper providing results from diabetic patients.
Conclusions: this kind of food will certainly help people with diabetes eat pizza without risking any serious deterioration of their own glucose control while fully enjoying socially active life.

1. Introduction

In the recently paper "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." [1] we reported on compared effects of three different kinds of Neapolitan pizza on both post-meal glucose and palatability/digestibility in 50 people with type 1 diabetes (T1DM) using an insulin pump. Those three kinds of pizza were made of either white refined "00" wheat flour (00F or "traditional", Pizza 1), whole wheat flour (WWF, Pizza 2) or mixed flour (MF, Pizza 3), the latter being made of WWF and Kamut flour (KF) added with glucomannan (GM) [1].

As opposed to Pizza 2, Pizza 3 caused no gastro-intestinal troubles and, despite being as tasty and digestible, triggered lower 2-, 4- and 12-h post-meal glycemic spikes than Pizza 1. Thanks to that, people with diabetes can now get the chance to eat a tasty, yet non-traditional pizza without running the risk to get overly hyperglycemic.

Biochemical, nutritional and organoleptic features of MF components are the following:

1. **WWF** is a soft wheat (*Triticum aestivum*) based milling product containing a significant amount of bran and can be progressively refined down to 2, 1, 0 and 00F flours. As set forth in the law, 00F and WWF have the following composition:
   00F: 13.9–14.5% water, 8–9% proteins, 1–2% lipids, 84.7–85% carbohydrates (mainly starch), 1–1.5% fiber, 0.4–0.5% mineral salts (magnesium, potassium, iron, copper and zinc)

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WWF: 13.9–14.5% water, 12–13% proteins, 9–10% lipids, 79.5–80% carbohydrates, 2–2.5% fiber, 1.5–2% mineral salts (magnesium, potassium, iron, copper and zinc) [2–4].

2. **KF** derives from Khorasan (*Triticum turgidum ssp. Turanicum*) wheat grinding as commercialized by Kamut® after which it is named. Khorasan is an ancient grain with larger and nutritionally more efficient beans than common wheat (higher protein, vitamin and mineral salt content). The great amount of gluten (with 40% higher protein content than WWF) and the low glycemic index (i.e. 45 vs 00F's 85) make Kamut good for dough and oven product development while yielding anti-hyperglycemic effects [2–6].
3. **GM** is extracted from the *Amorphophallus konjac* tuber used in Japanese cuisine as thickening agent [7,8]. By attracting high amounts of water, its purified form generates a soft gelatinous mass 60 to 100 times larger than original volume which provides efficient weight loss when added to a low-calorie diet [8–11]. It clinically most relevant features are: (i) resistance to hydrolytic gastric enzymes keeps it unaltered until reaching the gut where it is at least partially catabolized by microbiota into biologically active substances including short chain fatty acids, mannose and other sugar residues which directly interact with gut microbiota, and (ii) its unchanged portion increases fecal bulk by attracting water and thus enhances defecation and mechanically delays carbohydrate and fat absorption [11–19].

Our original hypothesis was that adding KF and GM to WWF in appropriate amounts might enable us to develop leavened bakery products endowed with low glycemic index (LGI), good taste and pleasant texture without missing any dough workability/leavening features compared to traditional ones.

So, the main aim of our study was to achieve the right mix of those elements for a LGI pizza. The secondary aim was to avoid typical adverse effects of commonly used WWF products, including abdominal bloating, flatulence or gastro-intestinal troubles.

2. Materials and methods

The best ratio of components contributing to Pizza 3 was established based on a series of preliminary tests as described below.

Single Pizza 3 preparation included the following operational steps:

1) brewer's yeast was dissolved in water q.s. at medium temperature (35 ± 2 °C)
2) WWF was added;
3) salt was added;
4) KF was added;
5) the resulting mix was kneaded for 3 ± 2 min;
6) Glucomannan was added at the end;
7) the blend was kneaded again for 30 s;
8) and allowed to "rest" for 15 min;
9) standard weight (preferably 200 g) balls were obtained from that;
10) balls were then let rise at 4 °C for 36 h;
11) and kept 3–4 h at room temperature before use thereafter;
12) the dough was rolled out into the characteristic pizza shape;
13) condiments were added;
14) the pizza was put to cooking in the electric oven at 359–380 °C for some 60–90 s (preferably 80 s).

The same steps except for 4 through 7 were followed for the other two kinds of pizza: without further changes for Pizza 2 and with 00F instead of WWF at step 2 for Pizza 1.

Table 1
Description of the four different pizza component proportions (Kamut, WWF and Glucomannan) selected to find out the optimal blend in the presence of stable water, salt and brewer's yeast amounts.

	TEST n.1	TEST n. 2	TEST n. 3	TEST n. 4
KF (g)	72 ± 2	70 ± 2	70 ± 2	68 ± 2
WWF (g)	33 ± 2	32 ± 2	30 ± 2	30 ± 2
GLUCOMANNAN (g)	5 ± 0.5	8 ± 0.5	10 ± 0.5	12 ± 0.5
SALT[a] (g)	2 ± 0.2	2 ± 0.2	2 ± 0.2	2 ± 0.2
BREWER'S YEAST (g)	0.2 ± 0.05	0.2 ± 0.05	0.2 ± 0.05	0.2 ± 0.05
WATER (ml)	87.8 ± 1	87.8 ± 1	87.8 ± 1	87.8 ± 1

[a] from State Monopolies.

Kneading was ensured by "Comida by Zanoli mod. Demetra pizza 30s" device (1.1 kw power supply, Speed 2) for a maximum of 30 kg dough contributed to by 20 Kg flour and 10 Kg water (intended to be 50% in weight at least). Air temperature and relative humidity were kept constant within the work environment (20–24 °C and 40–60%, respectively) for the entire processing time, as recorded by a thermo-hygrometer equipped with a continuous monitoring sensor-based datalogger (HHM8229, Omega Engineering Northbank, Irlam, Manchester, UK).

To come up with Pizza 3, we made preliminary tests using the three main components in different amounts. We started from 70% KF, 30% WWF and 10% Glucomannan and then slightly changed their relative proportions to get different mixes as reported in Table 1.

Evaluation of best mix was performed through a self-administered questionnaire by four well-experienced professional pasta-making masters, one nutritionist, five diabetologists, one nurse and twenty tasters, i.e. people with T1DM free from any organic, functional or allergic gastrointestinal (GI) pathologies, as well as, coeliac condition to rule out any possible GI disease-related interferences. Subjects with T1DM, and the other testers were randomly chosen people participating in the twin paper [1]. After that we evaluated organoleptic and especially post-cooking features of the three kinds of pizza under study by garnishing them with some of most traditional condiments using a variety of specifically quantified elements as previously described [1].

The questionnaire included the following 8 items with rating scores ranging from 1 (very bad/not at all) to 5 (very good/yes definitely):

1) Technical section[2]:
   (i)quality of dough during processing;
   (ii)quality of dough after processing;
   (iii) processing quality;
   (iiii) quality of ball draft;
   (iiiii) quality of pizza cooking.
2)Liking/digestibily-related section[3]:
   (i)did you like eating it?
   (ii)do you feel weighed down at the end of the meal?
   (iii) did you experience gastric discomfort, low digestibility, swelling, flatulence, abdominal distention and crampy pain, during the 2 h after meal?

[2] to be completed only by pasta-making masters during both MF best blend selection phase and following Pizza 1 to 3 evaluation.
[3] to be completed by all (nutritionist, masters and tasters) for Pizza 1 to 3 evaluation.

2.1. Statistical analysis

Results were expressed as either means ± SD or %. Differences were tested by analysis of variance (rANOVA), and Mann-Whitney test, for parametric and non-parametric variables, respectively, and by $\chi 2$ integrated by two-tailed paired Student's t-test as needed. The measure of agreement among professional pasta-making masters was evaluated by the test of positive and negative agreement as occurring by-chance (Cohen k). A $p < 0.05$ was chosen as the least acceptable level of statistical significance. All evaluations were performed using the SPSS/PC + software (IBM SPSS Statistics 2015).

3. Results

The best and top score for MF dough was reached during test 3 (see Table 1): all four pasta-making masters provided the top rating (i.e. 25), with a 100% concordance. We therefore chose that mix (i.e. 70 ± 2 g kF, 30 ± 2 g WWF and 10 ± 0.5 g Glucomannan) for Pizza 3 thereafter, which, from now on, will be referred to as the one made of such blend.

Mean scores obtained at the liking/digestibility-related section of the questionnaire, as summarized in Table 2, clearly show that Pizza 1 and Pizza 3 are virtually superimposable and both perform better than Pizza 2 which in turn, as shown in Table 3, results into low palatability and higher rates of gastrointestinal side effects, present in about 50% tasters (see questionnaire 2/iii).

4. Discussion and conclusions

Our previous twin-paper aimed to find out a suitable way to let people with DM – especially those with T1DM – eat pizza, one of their favorite food, without facing the large usually associated glycemic excursions [1]. We showed that our LGI pizza containing a specific blend of KF, GM and WWF (i) had a lower impact on postprandial hyperglycemic spikes than pizza made of whole wheat flour, (ii) was as pleasant and appreciated as TP and (iii) caused no gastro-intestinal troubles. We therefore thought it dutiful from our side to describe the validation process underlying the choice of the final blend in greater detail in order to make the whole procedure transparent and easy to carry out by anyone willing to capitalize on the benefits of that specific LGI pizza.

The relative proportion of KF and WWF was deliberately chosen since the beginning as a rough 70:30 ratio in order to keep wholegrain rather low and let fiber content increase thereafter by adding GM in amounts taking into account physico-chemical structure and expected bio-mechanical effects. In fact, its high hygroscopic capacity results into a poorly-processable dough and its kneading- and cooking-resistant grainy texture makes the final leavened product rather unpleasant to palate and tongue while large doses cause abdominal side effects (i.e. swelling, flatulence, wall distention and crampy pain). The procedure we described and the results of the tests performed to get the best flour mix with low glycemic index and good palatability/digestibility can contribute to a wide spread dissemination of such rather healthy bakery product.

Table 2
Scores obtained at the liking/digestibily-related section of the questionnaire (means ± SD).

	Question 1	Question 2	Question 3
Pizza 1	4.9 + 0.1	2.1 + 0.5	1.5 + 0.3
Pizza 2	2.6 + 0.6**	4.2 + 0.3**	3.8 + 0.4**
Pizza 3	4.7 + 0.3	2.0 + 0.3	1.4 + 0.3

**p < 0.01 vs pizza 1 and 3.

Table 3
Rating of tasters for the three pizzas (%). *GI stays for "gastro-intestinal".*

	PIZZA 1	PIZZA 2	PIZZA 3
Pizza Rating (liked)	85%	50% **	80%
Low Digestibility	15%	60% **	15%
GI Side Effects	5%	40% **	5%

**p < 0.01 vs Pizza 1 and Pizza 3.

Pizza has become a quite common food all over the world and its consumption is increasingly widespread with diabetes prevalence [20–22], so that the availability of a low glycemic index pizza equally tasty as traditional one would be highly desirable to reduce post-ingestion hyperglycemic spikes as in fact shown in our previous paper [1].

This represents an undeniable potential advantage of MF pizza and might hopefully become a healthy proposal if adopted by restaurants/pizzerias on a regular basis and could thus enhance patient adherence to updated diabetes management guidelines oriented to fully aware rather than restrictive food habits for people with T1DM and to an increasing role of lifestyle-related therapeutic education in any type of diabetes.

4.1. Limitations

We are fully aware of the fact that only three mixes were tested for pizza 3 and that only 4 people were involved in original MF composition choice and only one nutritionist, one nurse, five diabetologists, plus twenty tasters were involved in the following evaluation steps. This way we managed to reduce time and money resources needed to perform the study without giving up Nevertheless, the results we obtained here were fully confirmed by those reported in our previous paper on 50 people with T1DM on insulin pump, who almost unanimously preferred pizzas obtained through the MF prepared according to the final blend selected for Pizza 3 [1].

New added knowledge and clinical relevance of the study.

This is not the first paper dealing with positive effects fiber enriched meals and or on postabsorptive blood glucose, yet our paper contains a unique aspect as compared to similar previous studies, which in fact invariably showed the low palatability of high fiber products and ignored the long term postabsorptive phase by stopping less than 4 h after the meal [23,24].

Therefore, in terms of new knowledge, our study adds details concerning the best possible composition of a LGI food in our hands to be used by as many restaurants all over the world to prepare a healthy pizza on a regular basis and thus enhance patient adherence to updated diabetes management guidelines. The latter in fact are oriented to fully aware rather than restrictive food habits for people with T1DM and to an increasing role of lifestyle-related therapeutic education in any type of diabetes and the availability of a both healthy and tasty food may be of help.

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Authorship

All authors meet the International Committee of Medical Journal Editors (ICMJE) criteria for authorship for this article, 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, TDC and FS created the paper and wrote it. All have complied with data collection, critically assessed the results, and approved the final text.

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.

Declaration of competing interest

I Sandro Gentile Campania University "Luigi Vanvitelli", Naples, Italy, and Nefrocenter Research & Nyx Start-UP Study Group Coordinator.

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