Gastroenterology 2019;■:1–3

Preparation of Gluten-Free Foods Alongside Gluten-Containing Food May Not Always Be as Risky for Celiac Patients as Diet Guides Suggest

Vanessa M. Weisbrod,[1] Jocelyn A. Silvester,[2] Catherine Raber,[1] Joyana McMahon,[1] Shayna S. Coburn,[1] and Benny Kerzner[1]

[1]Celiac Disease Program, Children's National Health System, Washington, District of Columbia; and [2]Harvard Celiac Disease Program, Boston Children's Hospital, Boston, Massachusetts

Keywords: Celiac Disease; Gluten-Free; Gluten Cross-contact; Gluten contamination.

Celiac disease (CD) is a gluten-responsive inflammatory disorder with a worldwide prevalence of 1%. Avoiding gluten, a protein found in wheat, rye, and barley, is inherently challenging because gluten is ubiquitous, tasteless, and not always visible. Many patients with CD eat gluten-free (GF) food prepared in a home kitchen alongside gluten-containing foods. Fear of gluten exposure is common among CD patients and often leads to hypervigilance and decreased quality of life.[1] The Codex Alimentarius Commission defines GF as <20 parts per million (ppm) gluten.[2] GF diet guides published by professional societies, hospitals, and advocacy organizations suggest using dedicated toasters to prevent cross-contact with gluten and have conflicting recommendations regarding the need for dedicated utensils, leading to confusion for patients.[3,4] These recommendations are based on expert consensus with scant data to support them.[5] The aim of this study was to quantify gluten transfer when GF foods are prepared alongside gluten-containing foods. A secondary aim was to assess the efficacy of cleaning methods for kitchen equipment/utensils.

Methods

Three scenarios were developed to assess gluten transfer and efficacy of washing methods during food preparation: cooking pasta, toasting bread, and slicing cupcakes (Table 1).

Cooking Pasta

Sixteen-ounce packages of gluten-containing pasta (penne and fusilli) (Barilla USA, Northbrook, IL) were boiled separately in stainless steel pots of fresh tap water for 12 minutes, then removed using handheld strainers. Water was reused to cook GF penne and fusilli (Dr. Schär USA, Swedesboro, NJ). Cooked pasta was aliquoted into 2-oz servings to quantify gluten transfer. The effect of rinsing was tested by running additional cooked and contaminated pasta under cold tap water for 30 seconds. To test washing methods, pots used for gluten-containing pasta were rinsed with water alone or scrubbed with soap and water, then used to cook GF pasta in fresh boiling tap water.

Toaster

GF bread (Artisan White Bread; Dr. Schär) was toasted in 2 rolling toasters (Spectrum, ECT-500; Winco, Lodi, NJ) and (Belleco Conveyor Toaster, JT1; Belleco, Saco, ME) in a busy hospital cafeteria at 20-minute intervals, or in 1 of 3 shared pop-up toasters (Cuisinart, CPT-160, CPT-180 and Elite Cuisine, ECT-1027; Cuisinart, Stamford, CT) immediately after toasting gluten-containing bread (Nature's Own Whole 100% Wheat [Flowers Foods, Thomasville, GA], Harvest Pride White and Wheat Sandwich Bread, Ultimate Grains Whole Grain Wheat Bread [H&S Bakery, Inc, Baltimore, MD], or What's A Bagel products). Gluten-containing crumbs were visible in all toasters. No cleaning procedures were attempted for toasters.

Slicing a Cupcake

Frosted gluten-containing cupcakes (vanilla cupcakes; Whole Foods Market, Washington, DC) were sliced once with a knife, which was reused to slice a frosted GF cupcake (vanilla cupcakes; Gluten-Free Bake House; Whole Foods Market). The knife was then washed in soap and water, rinsed in running water, or cleaned with an antibacterial hand wipe (Wet Ones; Edgewell, North Bergen, NJ) and a new GF cupcake was sliced. Both GF cupcakes were analyzed for gluten content.

Determination of Gluten Content and Data Analysis

Samples were individually packaged in plastic bags with randomized sample numbers. Entire items (ie, whole bread slice) were homogenized for analysis. Gluten content was assayed using an R5 sandwich enzyme-linked immunosorbent assay (R7001; R-Biopharm, Darmstadt, Germany), which has a limit of detection of 5 ppm gluten by Bia Diagnostics (Colchester, VT). Control samples were also tested. Quantity of gluten for samples was categorized as <5 ppm, 5–10 ppm, 10–20 ppm, or >20 ppm. Confidence intervals are based on binomial distribution.

Abbreviations used in this paper: **CD, celiac disease; GF, gluten-free; ppm, parts per million.**

0016-5085/$36.00
https://doi.org/10.1053/j.gastro.2019.09.007

Table 1. Gluten Content of GF[a] Pasta Cooked in the Same Pot as Gluten-Containing Pasta, GF Bread Toasted in Toasters Also Used for Gluten-Containing Bread and GF Cupcakes Cut With A Knife Used to Cut Gluten-Containing Cupcakes

	Gluten undetectable <5 ppm		Gluten detected 5–10 ppm		Gluten detected 10–20 ppm		Gluten detected >20ppm	
Preparation method	n (%)	95% CI	n (%)	95% CI	n (%)	95% CI	n (%)	95% CI
GF pasta								
Cooked in shared water (n = 12)	0	0–30	0	0–30	0	0–30	12 (100)	70–100
Cooked in shared water, then rinsed with cold water for 30 s (n = 6)	4 (66)	24–94	1 (17)	1–64	1 (17)	1–64	0	0–48
Shared pot washed with soap and water before cooking GF pasta (n = 6)	6 (100)	55–100	0	0–48	0	0–48	0	0–48
Shared pot rinsed with water before cooking GF pasta (n = 6)	6 (100)	55–100	0	0–48	0	0–48	0	0–48
Toaster								
GF bread toasted in communal rolling toaster (n = 20)	16 (80)	56–93	4 (20)	7–44	0	0–20	0	0–20
GF bread toasted in shared pop-up toaster (n = 20)	20 (100)	80–100	0	0–20	0	0–20	0	0–20
Cupcake								
GF cupcake sliced with knife used to cut gluten-containing cupcake (n = 30)	2 (7)	1–24	12 (40)	23–59	14 (46)	29–65	2 (7)	1–24
GF cupcake sliced with a washed knife	28 (93)	76–99	1 (3)	0.2–19	1 (3)	0.2–19	0 (0)	0–14
Soap and water	9	—	0	—	1	—	0	—
Water alone	9	—	1	—	0	—	0	—
Wet wipes	10	—	0	—	0	—	0	—

CI, confidence interval.
[a]Products containing <20 ppm gluten are eligible for a gluten-free label under the Codex Alimentarius Commission Standard.

Results

Control samples of GF pasta, bread, and cupcakes all tested below the limit of detection. Gluten was detected in all pasta samples cooked in water used for gluten-containing pasta (33.9 ppm to 115.7 ppm). Rinsing pasta under running tap water reduced gluten content to <20 ppm. The 2 samples with detectable gluten had only 5.1 ppm and 17.5 ppm gluten. Rinsing pots with water alone after cooking gluten-containing pasta was as effective as scrubbing with soap and water to prevent detectable gluten transfer. Toasting in a shared toaster was not associated with gluten transfer >20 ppm; the 3 samples with detectable gluten had levels ranging only from 5.1 ppm to 8.3 ppm gluten. Although 28 of 30 cupcake samples had detectable gluten transfer, only 2 of 28 tested >20 ppm. All 3 knife-washing methods were effective in removing gluten.

Discussion

Of the 3 scenarios tested, cooking GF pasta using shared water was the riskiest, resulting in gluten levels >20 ppm in all samples tested. The risk of gluten cross-contact may be mitigated by rinsing the pasta, which reduced gluten content to <20 ppm. Alternatively, simply rinsing pots with clean water or scrubbing with soap and water before cooking GF pasta in fresh water may be a safer approach. Surprisingly, gluten transfer using a shared toaster was minimal, even with visible accumulation of gluten-containing crumbs in the toaster pans. Cutting cupcakes with a knife used to cut frosted gluten-containing cupcakes was associated with low-level gluten transfer, even when crumbs were visible on the icing adhered to the knife.

Some kitchen activities may pose less of a risk of cross-contact with gluten than is commonly believed. Moreover, the risk may be readily mitigated by washing with water. In a small study, Studerus et al[5] also found that dedicated kitchen equipment or preparation areas for GF foods may be unnecessary if appropriate cleaning methods are employed consistently. In addition, Miller et al[6] reported that a 2-m radius from wheat flour and good hygiene practices facilitated simultaneous preparation of GF meals alongside gluten-containing ones.

Acknowledged limitations of our study include small sample size, subsampling of homogenized foods, and use of sandwich rather than competitive enzyme-linked immunosorbent assay, which is able to detect hydrolyzed gluten.

Cross-contact will inevitably vary in different kitchen environments. It is important for CD patients to continue to ask questions about methods used to prepare GF foods, while at the same time recognizing that some practices may present a higher risk than others and vigilance must be directed appropriately. Future larger studies in home and commercial cooking environments should address a wider range of scenarios, cooking surfaces, and types of food. Such studies are needed to inform evidence-based recommendations for best practices for GF food preparation that balance risk of gluten exposure with harm from anxiety and hypervigilance.

References

1. Wolf RL, et al. Dig Dis Sci 2018;63:1438–1448.
2. Codex Alimentarius Comission. Codex Stan 2008:3–5.
3. AGA Institute. https://aga-cms-assets.s3.amazonaws.com/201822216377—All_CeliacDisease_2017.pdf.
4. Guandalini S, et al. https://www.cureceliacdisease.org/wp-content/uploads/CdC_Essentials_Guide_EBOOK_2018.02.05.pdf.
5. Studerus D, et al. J Food Prot 2018;81:1679–1684.
6. Miller K, et al. J Food Prot 2016;79:282–287.

Received August 2, 2019. Accepted September 16, 2019.

Reprint requests
Address requests for reprints to: Vanessa Weisbrod, BA, CA, Department of Gastroenterology, Children's National Health System, 111 Michigan Avenue NW, Washington, DC 20010. e-mail: vweisbro@childrensnational.org.

Acknowledgments
The authors acknowledge Dr Amy Damast, Maureen Basye, Blair Raber, and Chloe Lerner for their assistance with cooking and sample preparation, and Dr Rima Izem for providing the initial statistical methods plan and randomization table for the cupcake scenario.

Author contributions: Study conception and design: BK, JM, CR, VMW. Data analysis and interpretation: SSC, BK, JAS, VMW. Drafted initial manuscript: JAS, VMW. All authors reviewed and approved the final manuscript as submitted and agree to be accountable for all aspects of the work.

Conflicts of interest
This author reports the following: Jocelyn A. Silvester has served on an advisory board of Takeda Pharmaceuticals and received research support from Cour Pharma, Glutenostics, and the Celiac Disease Foundation. The remaining authors disclose no conflicts.

Funding
Supported by philanthropic gifts from the Celiac Disease Foundation, Dr. Schär USA, and Bia Diagnostics. JAS is supported by the National Institute of Diabetes and Digestive and Kidney Diseases of the National Institutes of Health under Award Number K23DK119584. The content is solely the responsibility of the authors and does not necessarily represent the official views of the National Institutes of Health.