به نام خدا

گروه علوم و صنایع غذایی (کنترل کیفی و بهداشتی)

ژورنال کلاب با عنوان مقاله

تهیه پاستای بدون گلوتن با آرد ذرت، برنج و کینوا حاوی هیدروکلوئیدها

ارائه دهندگان: **عاتکه خوشبخت_ عطیه پازوکی شاهسوند**

استاد راهنما: **دکتر هما بقایی**

تاریخ ارائه: ۱۴۰۴/۰۸/۰۱

مجله علوم زیستی و فناوری غذایی

In the name of God

Department of Food Science and Technology (Quality Control & Hygiene)

Journal Club with the title of the article

Gluten-Free Pasta Based on Corn, Rice, and Quinoa Flours Plus Hydrocolloids

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Journal of Food Biosciences and Technology

فهرست

جدول اختصارات

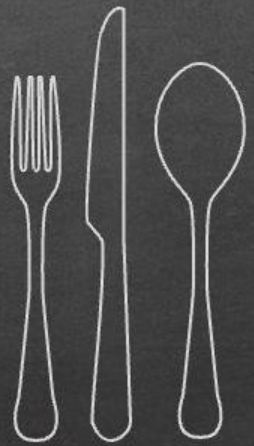
اصطلاح	معادل انگلیسی	تعریف
GL	Gluten-Free	بدون گلوتن
XG	Xanthan Gum	صمغ زانتان
β-glucan	Beta-Glucan	بتا-گلوکان
RDS	Rapidly Digested Starch	نشاسته با هضم سریع
SDS	Slowly Digested Starch	نشاسته با هضم آهسته
RS	Resistant Starch	نشاسته مقاوم

جدول اختصارات

اصطلاح	معادل انگلیسی	تعریف
OCT	Optimum Cooking Time	زمان پخت بهینه
MC	Moisture Content	میزان رطوبت
a_w	Water Activity	فعالیت آبی
TPA	Texture Profile Analysis	آزمون پروفایل بافت
ANOVA	Analysis of Variance	تحلیل واریانس

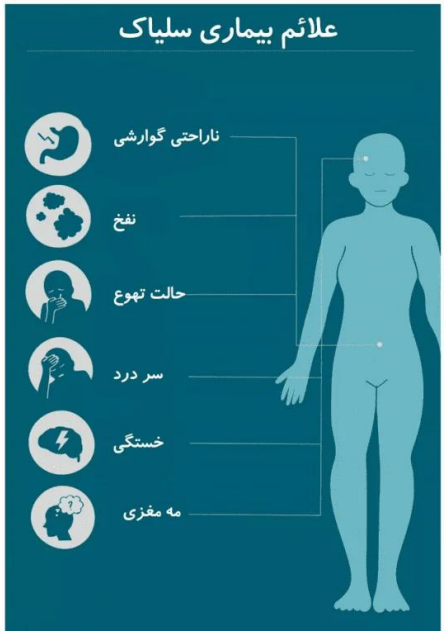
مرکز آموزش عالی
علوم پزشکی
وارستگان

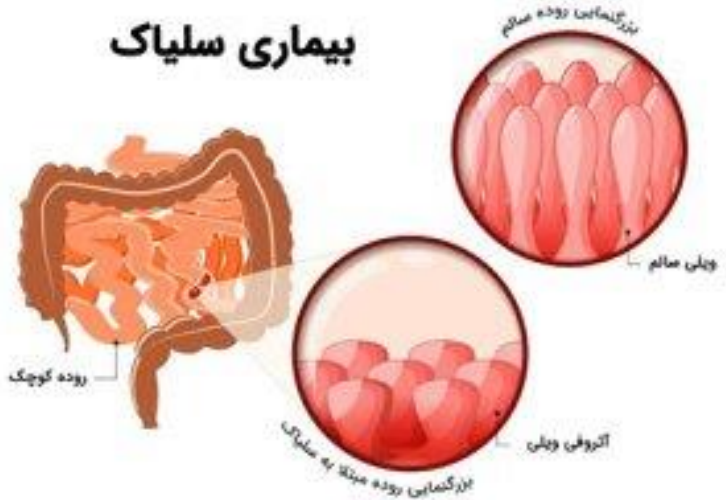
۱- مقدمه



بیماری سلیاک

بیماری سلیاک یک اختلال خودایمنی است که در آن سیستم ایمنی بدن به گلوتن، پروتئینی که در گندم، جو و چاودار وجود دارد، واکنش نشان می‌دهد. این واکنش می‌تواند به آسیب به بافت روده کوچک منجر شود و جذب مواد مغذی را مختل کند.





آرد ذرت

- بدون گلوتن، دارای طعم ملایم و کمی شیرین، قدرت غلیظ کنندگی بالا

آرد برنج

- بدون گلوتن، دارای طعم خنثی و لطیف، برای غلیظ کردن سس ها و سوپ ها

آرد کینوا

- بدون گلوتن، دارای ویژگی های قابل قبول مانند ویسکوزیته بالا و توانایی فریز شدن، سرشار ازپروتئین های مغذی، مواد معدنی، فولات، توکوفرول و فلاوونوئید هااست.

هیدروکلوئید های مورد استفاده

بتاگلوکان

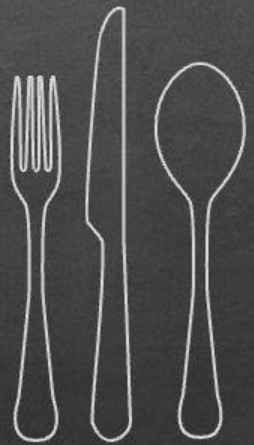
- استخراج شده از دیواره سلولی جودوسر، دارای فعالیت پری بیوتیک، عامل چسبندگی تثبیت و امولسیون کنندگی

زانتان

- یک هیدروکلوئید غیرنشاسته ای که ویسکوزیته و سفتی را افزایش می دهد و باعث ایجاد حس دهانی و بافت در محصولات نهایی میشود.

مرکز آموزش عالی علوم پزشکی وارستگان

۲- مواد و روش ها



مواد مورد استفاده درپژوهش

نام ماده	نام شرکت
آرد ذرت و برنج	North Powderiran
آرد کینوا	Farsine
صمغ زانتان	Pishgaman
صمغ بتاگلوکان	Soren Tak Toos
سایر مواد شیمیایی	Merk (Germany) and Sigma-Aldrich (USA)

نوع پاستای تولیدی (ریگاتونی) و فرمولاسیون

Table 1. The proportion of raw materials used for GF pasta samples and the control

Samples	Corn: rice: quinoa	XG (g/100g flour mixture)	B-glucan (g/100g flour mixture)
1	20:60:20	0.5	2
2		1	1.5
3		1.5	1
4		2	0.5
Control	Durum wheat flour		

آماده‌سازی و روش تولید پاستا

- ✓ تولید نمونه‌های پاستا به روش کمالی و همکاران (۲۰۲۰)
- ✓ افزودن ۷۰میلی لیتر آب به ۱۶۵گرم مخلوط آرد غنی شده با هیدروکلوئیدهای مورد استفاده یا آرد گندم دوروم
- ✓ تولید پاستای ریگاتونی در دمای ۲۵درجه سانتیگراد با دستگاه اکسترودر شرکت زرماکارون
- ✓ خشک شدن در دمای ۷۵ درجه سانتیگراد در خشک کن کابینتی

مخلوط کردن آب و آرد و صمغ

↓

اکسترودر به مدت ۱۰ دقیقه

↓

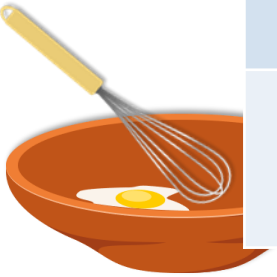
خشک کن کابینتی به مدت ۵ ساعت

آزمون‌های نمونه

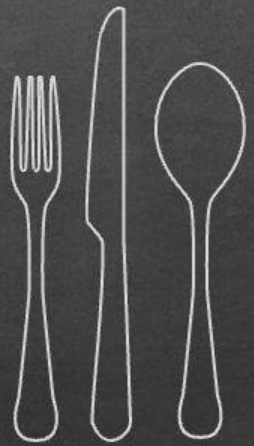
نوع آزمون	نام آزمون	روش آزمون	دستگاه
اندازه گیری ترکیبات شیمیایی	رطوبت-خاکستر-PH ومیزان پروتئین، چربی و فیبر	AOAC،2005	---
	aw	Demarchi et al.	AquaLab Dew Point Water Activity Meter 4TE, Decagon
کیفیت پخت	افت پخت	Makdoud and Rosentrater، 2017	ترازو
	جذب آب	Agama-Acevedo et al. ،2009	ترازو
	وزن پس از پخت	AACC, 2000	ترازو
	خواص رئولوژیکی خمیر	f Larrosa et al.، 2013	MCR301 Rotational Rheometer, Austria
	رنگ سنجی	Colorimeter	DP-9000, US

آزمون‌های نمونه

نوع آزمون	نام آزمون	روش	دستگاه
بافت سنجی	اندازه گیری سفتی	Warner-Bratzler	Texture Analyzer Hounsfield, H5KS, England
	TPA	Tazrart et al. (2018)	Texture Analyzer 6025, Instron co. England
درصد نشاسته هضمی	هضم و تعیین گلوکز آزاد شده	Kan et al. (2020) & Rovalino-Cordova et al. (2018)	---
فعالیت پری بیوتیکی	ارزیابی خاصیت پریبیوتیکی	Madhukumar & Muralikrishna, (2010)	---
آزمون حسی	5-point hedonic	Garbetta et al., 2020	---
آنالیز آماری	one-way analysis of variance (ANOVA)	Duncan test	SPSS.22 software



۳- نتایج و بحث



1-آنالیز ترکیبات شیمیایی

Table 2. Chemical composition and pH of pasta samples

Samples	Moisture content (% w/w)	Aw	Crude protein (%)	Crude fiber (%)	Ash (%)	pH
Control	11.75±0.06^{a}	65.61±0.27^{a}	11.48±0.07^{f}	1.82±0.06^{c}	0.78±0.02^{c}	5.40±0.01^{c}
1	10.63±0.06^{d}	64.15±0.27^{c}	11.72±0.07^{d}	1.87±0.06^{c}	0.39±0.02^{d}	6.01±0.01^{a}
2	11.02±0.06^{b}	65.32±0.27^{ab}	12.30±0.07^{b}	2.24±0.06^{b}	0.91±0.02^{a}	5.34±0.01^{c}
3	10.84±0.06^{c}	64.51±0.27^{bc}	12.53±0.07^{a}	2.85±0.06^{a}	0.84±0.02^{b}	5.30±0.01^{d}
4	9.64±0.06^{e}	64.28±0.27^{c}	11.97±0.07^{c}	1.89±0.06c	0.40±0.02^{d}	5.92±0.01^{b}

Each value is the mean ± standard deviation of three replicates. In each column, different superscript letters mean significant differences ($P<0.05$).

2- کیفیت پخت

Table 3. Cooking quality of the control and GF pasta samples

Samples	Optimum cooking time	Weight after cooking	Cooking loss	Water adsorption capacity
Control	9.05±0.19^{b}	49.35±0.34^{c}	30.48±0.14^{d}	23.61±0.21^{b}
1	8.47±0.19^{b}	50.87±0.34^{b}	32.22±0.14^{c}	16.93±0.21^{c}
2	10.21±0.19^{a}	53.12±0.34^{a}	32.31±0.14^{c}	23.94±0.21^{ab}
3	10.34±0.19^{a}	54.03±0.34^{a}	34.48±0.14^{a}	24.56±0.21^{a}
4	8.73±0.19^{b}	49.75±0.34^{c}	33.59±0.14^{b}	15.94±0.21^{d}

Each value is the mean ± standard deviation of three replicates. In each column, different superscript letters mean significant differences ($P<0.05$).

3- ویژگی های رئولوژیکی

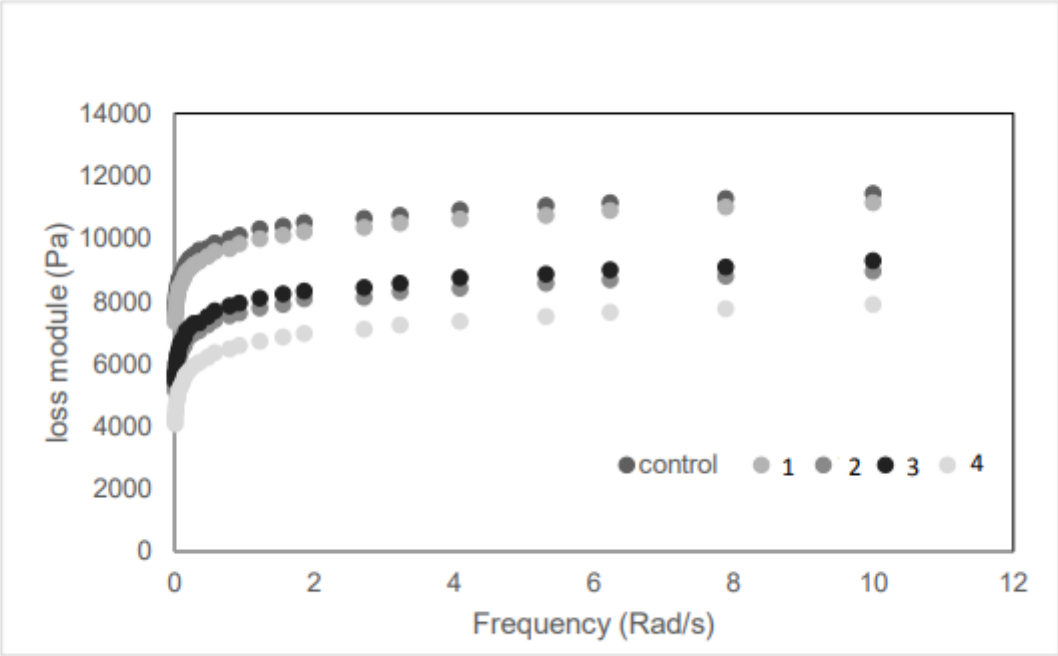
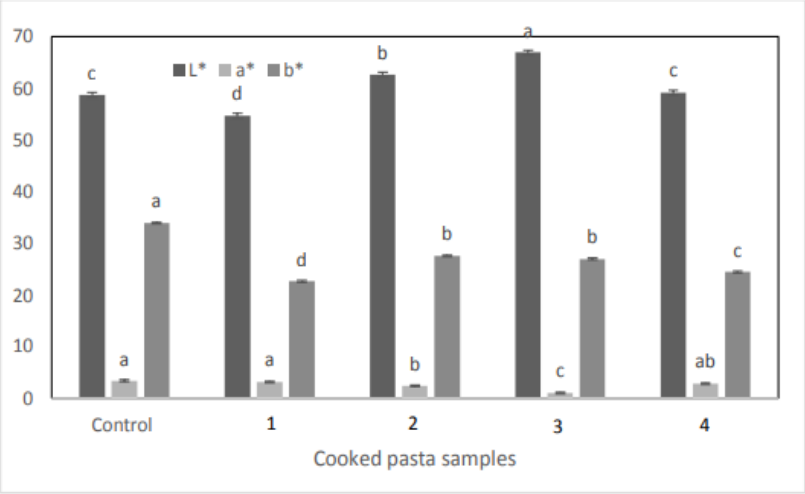


Fig. 1. Rheological analysis of the control and GF pasta samples (Storage and loss modulus vs frequency)

4- آزمون رنگ



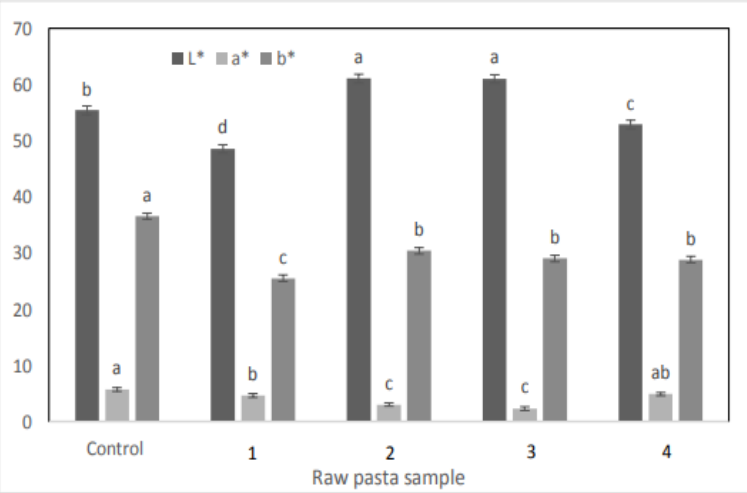


Fig. 2. The color factor of cooked and raw pasta samples.

5- آزمون بافت بر اساس نیروی برشی (وارنر- براتزلر)

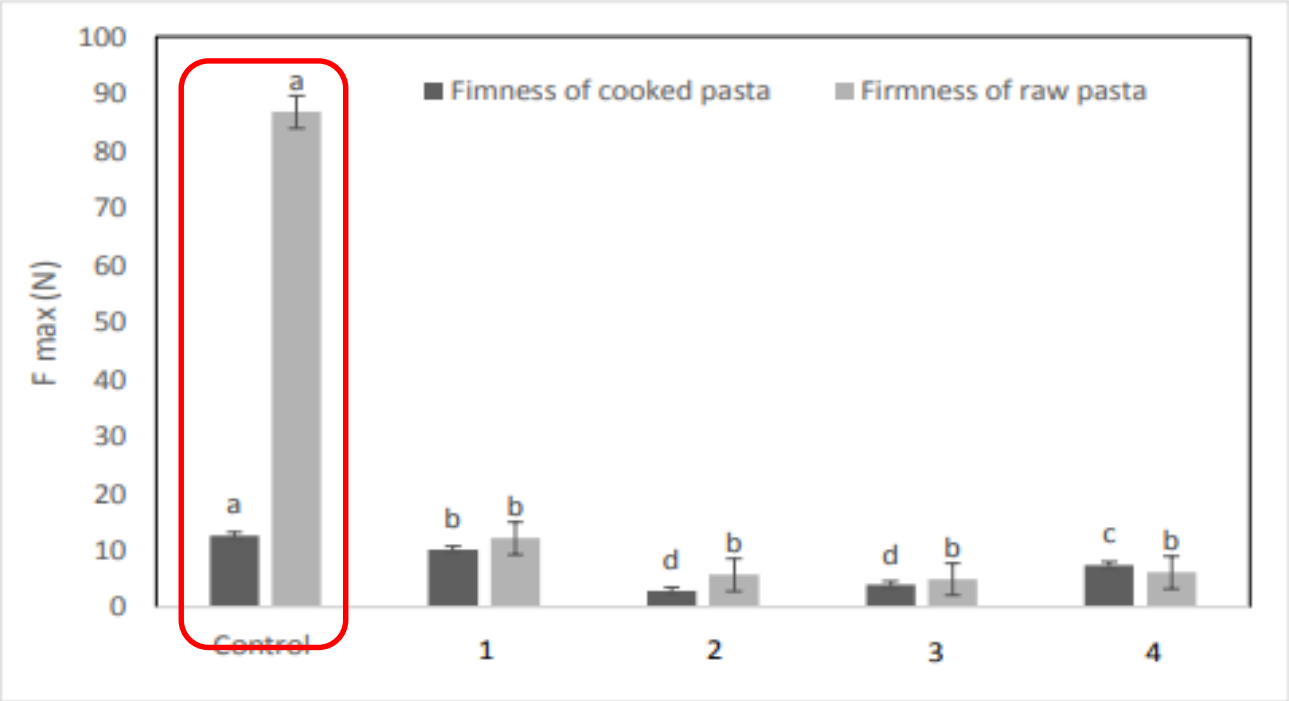


Fig. 3. Firmness (Fmax) of cooked and raw pasta samples.

آزمون بافت TPA

Table 4. The textural parameters of pasta samples with TPA test

Samples	Hardness	Adhesiveness	Cohesiveness	Elasticity	Chewiness
Control	42.20±1.34^{a}	1.11±0.00^{a}	0.66±0.02^{a}	0.69±0.18^{a}	17.44±0.87^{a}
1	40.56±1.51^{a}	0.97±0.03^{b}	0.66±0.02^{a}	0.62±0.07^{ab}	16.69±2.74^{a}
2	30.44±0.36^{c}	0.82±0.00^{c}	0.45±0.01^{c}	0.51±0.02^{b}	7.08±0.06^{c}
3	32.29±0.26^{b}	0.84±0.01^{c}	0.47±0.02^{c}	0.45±0.01^{b}	6.94±0.15^{c}
4	33.24±0.56^{b}	0.82±0.03^{c}	0.57±0.02^{b}	0.62±0.05^{ab}	11.66±1.12^{b}

Each value is the mean ± standard deviation of three replicates. In each column, different superscript letters mean significant differences ($P<0.05$).

۶- آزمون میزان فعالیت پری بیوتیکی

Table 5. Prebiotic activity and glucose release and different starch fractions of pasta samples

Samples	Prebiotic activity Log cfu/ml	Glucose release at 20 min	Glucose release at 120 min	RDS	SDS	RS
Control	7.47±0.08^{b}	55.60±2.55^{a}	93.65±0.61^{a}	52.74±0.87^{a}	31.55±0.78^{b}	15.72±0.55^{c}
1	7.20±0.08^{c}	55.57±2.55^{a}	91.69±0.61^{a}	50.01±0.87^{a}	32.52±0.78^{ab}	17.48±0.55^{c}
2	7.50±0.08^{b}	36.39±2.55^{b}	77.41±0.61^{b}	34.44±0.87^{b}	35.23±0.78^{a}	30.34±0.55^{b}
3	7.92±0.08^{a}	26.77±2.55^{c}	65.32±0.61^{c}	25.26±0.87^{c}	33.53±0.78^{ab}	41.21±0.55^{a}
4	7.20±0.08^{c}	36.88±2.55^{b}	65.32±0.61^{c}	34.94±0.87^{b}	24.26±0.78^{c}	40.80±0.55^{a}

۸-آزمون حسی

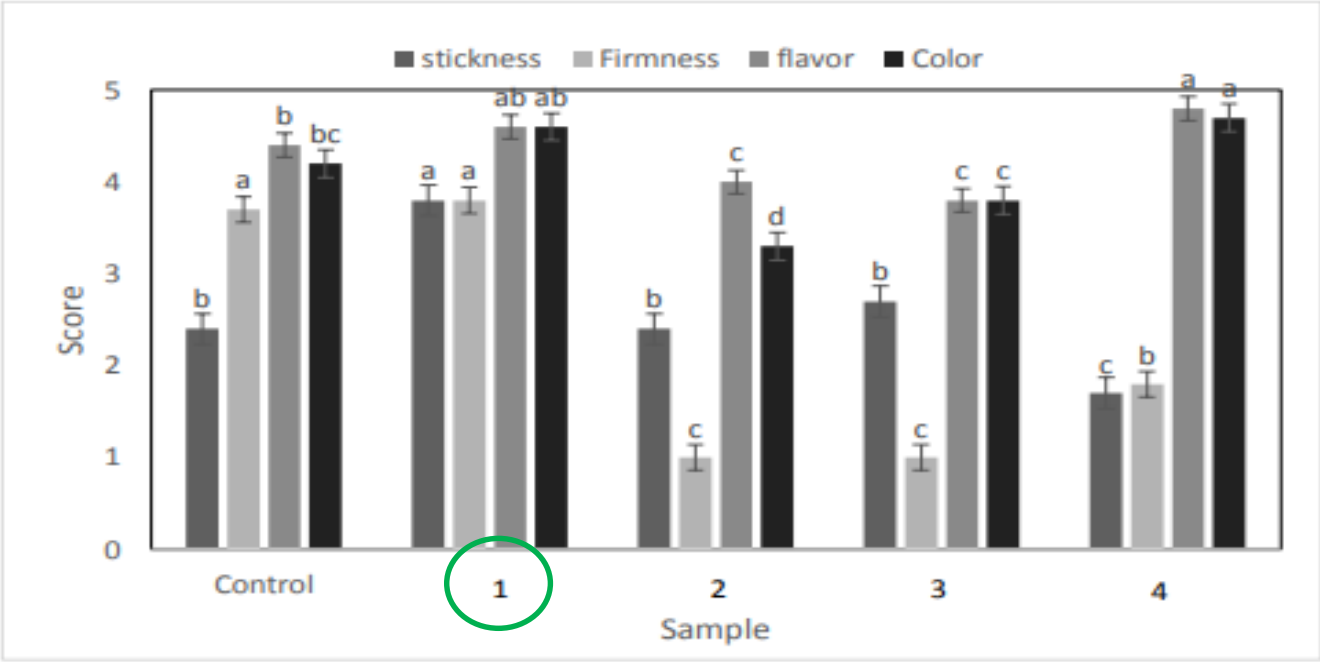


Fig. 5. Sensory evaluation of GF pasta and the control.

مرکز آموزش عالی
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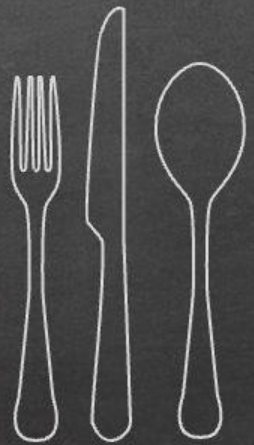
۴-نتیجه گیری نهایی

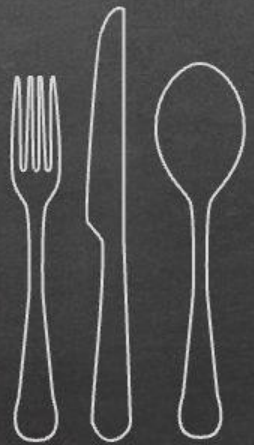


نتیجه گیری نهایی

- در این مقاله سعی شد که هدف فقط تولید محصول فاقد گلوتن نباشد، بلکه اثرات تغذیه‌ای فراورده (مانند کنترل قند خون و بهبود سلامت گوارشی) نیز در نظر گرفته شود.
- نسبت مناسب بتا-گلوکان (که اثرات مثبت بر قند خون و سلامت روده دارد) و زانتان گام (که بر بافت و قوام پاستا اثرگذار است) تعیین‌کننده‌ی کیفیت نهایی محصول بود.
- نتیجه اول پژوهش این بود که برای رسیدن به بهترین ویژگی های کیفی و عملکردی پاستا، استفاده از آردهای جایگزین گندم همراه با هیدروکلوئیدها ضروری است.
- نتایج آزمون تیمارهای مختلف نشان داد که از نظر حسی، نمونه شماره ۱ بهترین امتیاز را دریافت کرد اما نمونه شماره ۳ دارای بهترین امتیاز پارامترهای بافتی، گلیسمی و پری بیوتیکی بود که لازم است در پژوهش های بعدی بین این دو تعادل برقرار شود.

مرکز آموزش عالی علوم پزشکی وارستگان

۵- فهرست منابع



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به نام خدا

گروه علوم و صنایع غذایی (کنترل کیفی و بهداشتی)

ژورنال کلاب با عنوان مقاله

تهیه پاستای بدون گلوتن با آرد ذرت، برنج و کینوا حاوی هیدروکلوئیدها

ارائه دهندگان: **عاتکه خوشبخت_ عطیه پازوکی شاهسوند**

استاد راهنما: **دکتر هما بقایی**

تاریخ ارائه: ۱۴۰۴/۰۸/۰۱

مجله علوم زیستی و فناوری غذایی

In the name of God

Department of Food Science and Technology (Quality Control & Hygiene)

Journal Club with the title of the article

Gluten-Free Pasta Based on Corn, Rice, and Quinoa Flours Plus Hydrocolloids

By: Atekeh Khoshbakht- Atieh Pazooki Shahsavand

Supervisor: Dr. Homa Baghaei

Date: 2025/10/23

Journal of Food Biosciences and Technology

Journal of Food Biosciences and Technology

دانشگاه آزاد اسلامی واحد علوم تحقیقات

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Islamic Azad University
Science and Research Branch

Journal of Food Biosciences and Technology

Issue 1 Vol. 14 Winter 2024

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3 - Gluten-free pasta based on corn, rice, and quinoa flours plus hydrocolloids

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4 - Saffron Nanoemulsions: an emphasis on the two recent patents for ultrasonic Nanoemulsion of saffron

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نتایج بررسی نرم‌افزاری برای شناسه شاپا ۲۲۲۸۷۰۸۶

Journal of Food Biosciences and Technology

در تاریخ ۲۳ مهر ۱۴۰۴

با توجه به محدودیت‌های نرم افزاری، نتایج ارائه شده در این بخش نیازمند بررسی دقیق تر توسط کارشناس می‌باشد

در فهرست مجلات داخلی مورد تایید وزارت بهداشت یافت شد

در فهرست سیاه وزارتین و دانشگاه آزاد اسلامی یافت نشد

در فهرست مجلات نمایه JCR (دارای ضریب تاثیر) یافت نشد

در فهرست مجلات نمایه شده Master Journal List یافت نشد

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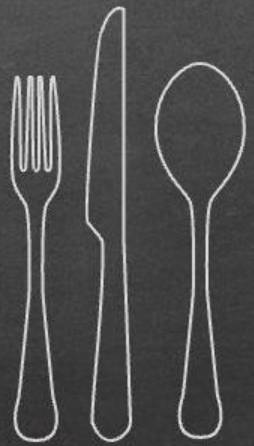
Title	ضریب ISC
journal of food biosciences and technology	۰.۱۳۶

در فهرست مجلات نشریات علمی دانشگاه آزاد اسلامی قرار دارد

۱- نقد ویراستاری 🔍



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Authors : Full postal addresses must be given for all co-authors. The corresponding author should be identified (include a Fax number and E-mail address) with an asterisk and footnote. All other footnotes (except for table footnotes) should be identified with superscript Arabic numbers.

Gluten-Free Pasta Based on Corn, Rice, and Quinoa Flours Plus Hydrocolloids

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[b*] Professor of the Department of Food Science and Technology, Science and Research Branch, Islamic Azad University, Tehran, Iran.
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[b] Assistant Professor of Agricultural Engineering Research Institute (AERI), Agricultural Research, Education and Extension Organization (AREEO), Karaj, Iran.

Manuscript Preparation

It is suggested that the authors prepare their manuscripts in the following manner:

- Title, Authors, Affiliation
- Abstract, Keywords
- Main text (Introduction, Materials and Methods, Results and Discussion, Conclusion)
- Acknowledgement
- Figures and Tables
- References

Abstract **:** Each paper should be provided with an abstract of 150-200 words, which state the purpose of the study, basic procedures, main findings and the principal conclusions.

Keywords : Authors are asked to list in alphabetical order up to 5-7 key words or phrases that describe the subject matter of their paper.

Introduction **:** The introduction should not be a lengthy review of all background literature. It should be limited to identifying the gap in scientific knowledge or the problem that the research addressed.

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Submission of Papers: All papers must be written in English according to sound grammar and proper terminology.

ABSTRACT: The new gluten-free pasta formulations based on the ratio of corn: rice: quinoa flours (20:60:20) enriched with the different percentages (0.5, 1, 1.5, and 2%) of β-glucan and xanthan (XG) were produced to reduce the gluten-related diseases and glycemic responses. These were then compared with each other and the control (wheat flour) in terms of texture, chemical composition, rheology, color, cooking quality, sensory analysis, prebiotic activity, glucose release, rapidly and slowly digested starch (RDS and SDS), and resistant starch (RS). The highest and lowest values of loss and storage moduli were for the control and sample 1 (2% β-glucan and 0.5% XG), respectively. The control and sample 1 were also comparable in terms of textural and sensorial characteristics. The L* (brightness) of cooked and raw sample 3 reached maximum level, and the highest values of b* and a* were associated with the cooked and raw control. The superior cooking quality was related to the sample 3 (1.5% β-glucan and 1% XG) while sample with 0.5% β-glucan and 2% XG had the minimum value. Regarding functional properties, the sample 3 was the superior sample in terms of prebiotic activity, glucose release, RSD, and RS while the control showed the maximum glucose release in all digestion intervals.

✘ New gluten-free pasta formulations based on the ratio...
to reduce the risk of gluten-related diseases and glycemic responses
Superior cooking quality was related to sample…

150-200 words ✓

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Keywords: Functional Properties, Gluten Free Pasta, Glycemic Responses, Hydrocolloids, Physicochemical Properties.

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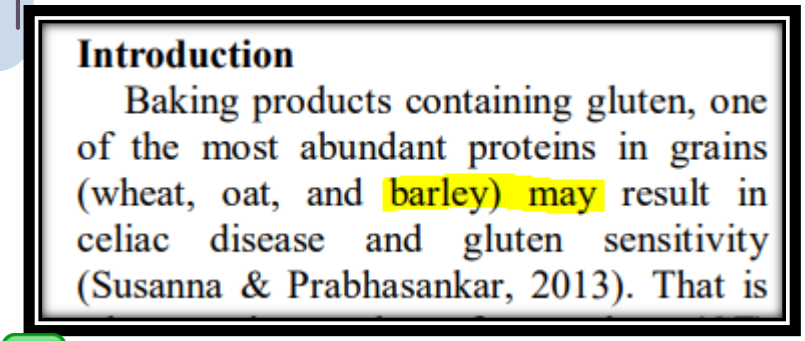
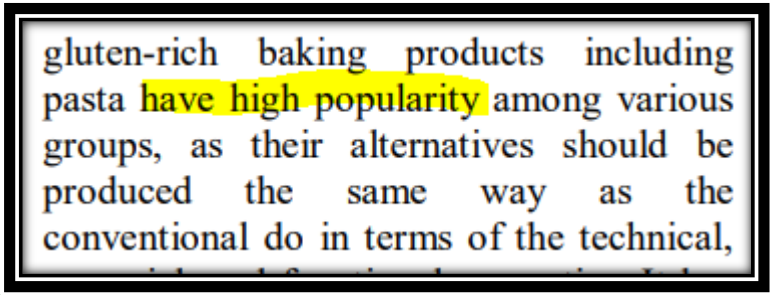


Introduction

Baking products containing gluten, one of the most abundant proteins in grains (wheat, oat, and barley) may result in celiac disease and gluten sensitivity (Susanna & Prabhasankar, 2013). That is

✅ (wheat, oat, and barley), may result in…



gluten-rich baking products including pasta have high popularity among various groups, as their alternatives should be produced the same way as the conventional do in terms of the technical,

✅ are highly popular among various groups...

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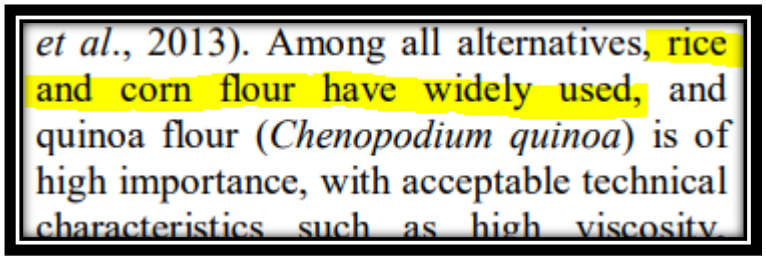
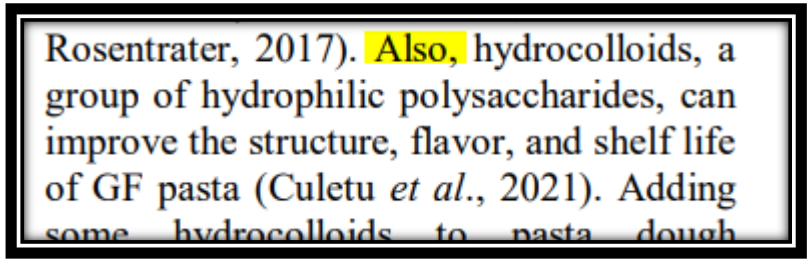

et al., 2013). Among all alternatives, rice and corn flour have widely used, and quinoa flour (*Chenopodium quinoa*) is of high importance, with acceptable technical characteristics such as high viscosity.

✅ rice and corn flours have been widely used...


Rosentrater, 2017). Also, hydrocolloids, a group of hydrophilic polysaccharides, can improve the structure, flavor, and shelf life of GF pasta (Culetu *et al.*, 2021). Adding some hydrocolloids to pasta dough

✅ Hydrocolloids, which are hydrophilic polysaccharides, can improve…

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- ***Weight after cooking***

It was evaluated base on the procedure 66-50 of AACC (AACC, 2000). Briefly, the cooked pasta samples were drained and weighed when 12 g of raw pasta sample was boiled in 500 ml of water for OCT. The cooking weight was calculated based

✅ based on the procedure…
and then weighed after boiling 12 g of raw pasta sample in 500 ml of water…

samples ($p<0.05$). The control had the highest MC and aw while the lowest MC and aw was related to sample 4. it is related to the high-water holding capacity

✅ It is related to the high water-holding capacity…

استفاده از منابع قدیمی

- ***Measurement of chemical compositions***

The contents of pH, protein, fat, fiber, moisture, and ash in the samples were determined based on AOAC methods (AOAC, 2005). Water activity was evaluated according to the method stated by Demarchi *et al.* (2013) and was measured using a water activity meter (AquaLab Dew Point Water Activity Meter 4TE, Decagon).

- ***Optimal cooking time***

It was determined according to the method of AACC 66-50 (AACC, 2000). Briefly, 5 g of dried pasta sample was boiled in 200 ml of water and squeezed between two pieces of glass until disappearing the white center core.

رعایت نکردن شیوه صحیح نوشتن فرمول ها

- Water absorption of cooked pasta

It was measured according to the method stated by Agama-Acevedo *et al.* (2009). 12.5 g of pasta samples were boiled in 200 ml of distilled water before draining and rinsing with 50 ml of the distilled water for 1 min and then weighing. This factor was calculated with equation 2: ((CPW-DPW)/DPW) × 100, where CPW and DPW are the weights of the cooked drained pasta and the raw pasta, respectively.

- Weight after cooking

It was evaluated base on the procedure 66-50 of AACC (AACC, 2000). Briefly, the cooked pasta samples were drained and weighed when 12 g of raw pasta sample was boiled in 500 ml of water for OCT. The cooking weight was calculated based on equation 3: ((Wc-Wd)/Wd)×100, where Wc and Wd were weights of cooked and dry pasta, respectively.

- Cooking loss

It was evaluated according to the method described by Makdoud and Rosentrater (2017). Briefly, the remaining solid particles in cooking water were weighed after drying in an oven at 50 ºC for 48 hours. The cooking loss percentage was calculated with equation 1: ((DPW - OPW) /DPW) × 100), where DPW and OPW are the weights of raw and dried pasta, respectively.

عدم رعایت subscript

a_w

- ***Analysis of chemical composition***

Table 2 shows the chemical analysis of pasta samples. There were significant differences among the moisture content (MC) and water activity (aw) of pasta samples ($p<0.05$). The control had the highest MC and aw while the lowest MC and aw was related to sample 4. it is related to the high-water holding capacity

Fig. 3. Firmness (Fmax) of cooked and raw pasta samples.

F_{max}

مشابه بودن رنگ های نمودار

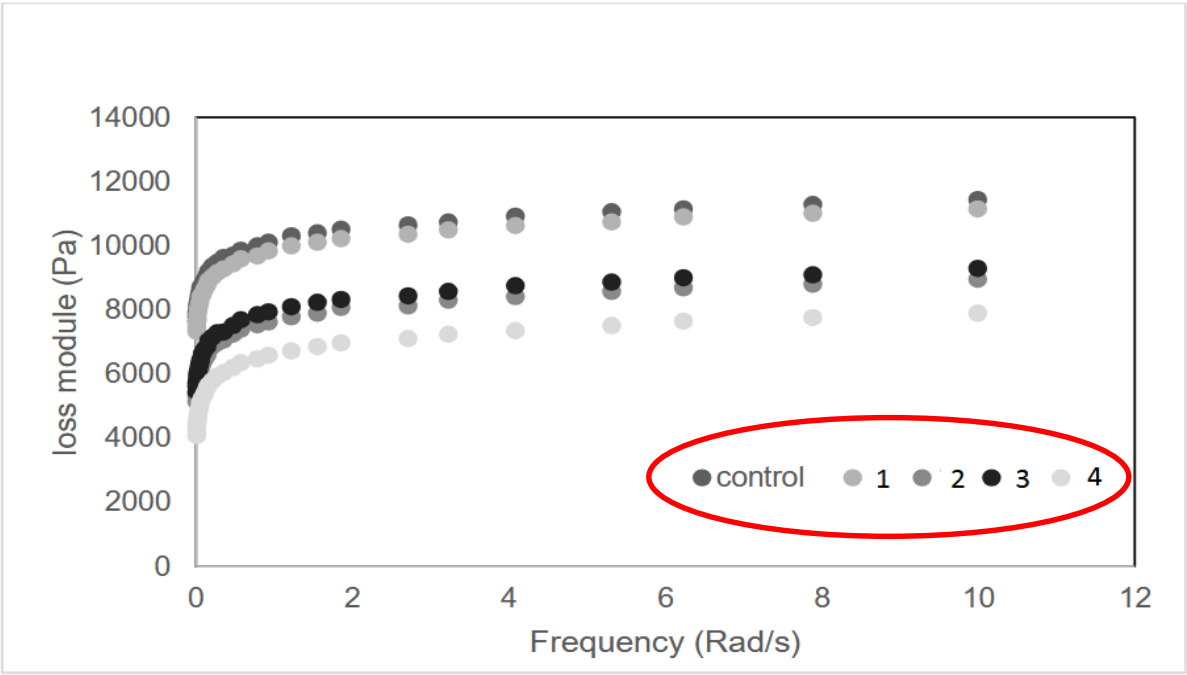

Fig. 1. Rheological analysis of the control and GF pasta samples (Storage and loss modulus vs frequency)

مشابه بودن رنگ های نمودار

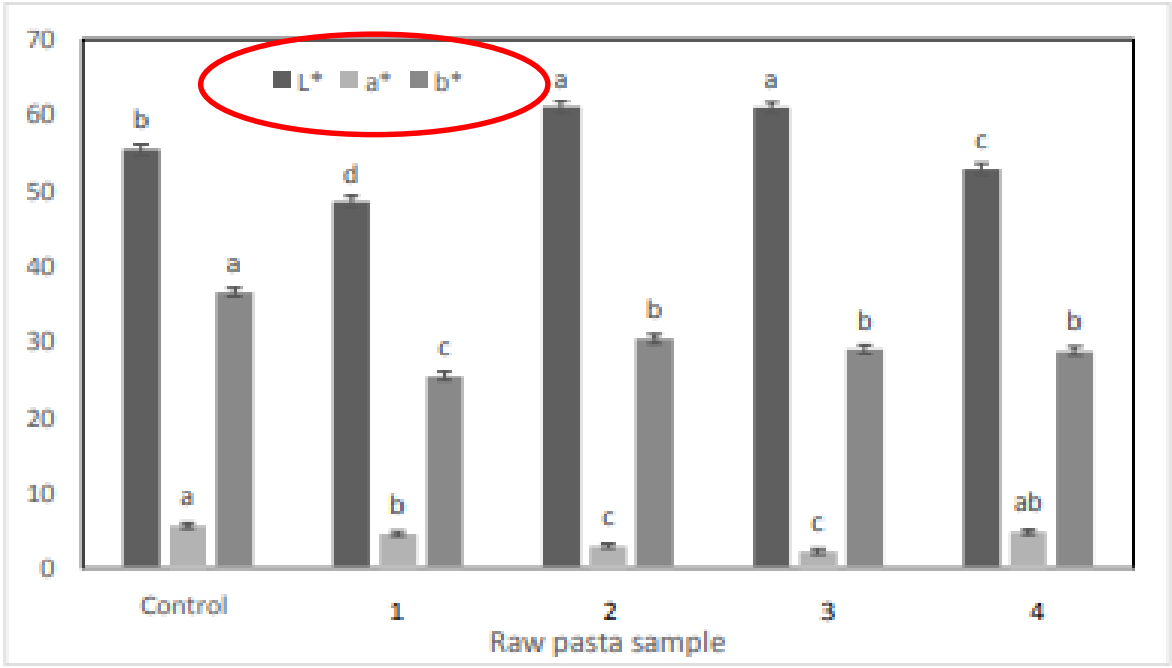

Fig. 2. The color factor of cooked and raw pasta samples.

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References **:**

- In the text refer to the author's name (without initials) and year of publication. For 2 authors all authors are to be listed.
- When there are more than 2 authors, first author et al. Should be used throughout the text. The list of references should be arranged alphabetically by authors' names and should be as full as possible, listing all authors, the full title of articles and journals, publisher and year.

(AOAC, 2005). Water activity was evaluated according to the method stated by Demarchi *et al*. (2013) and was

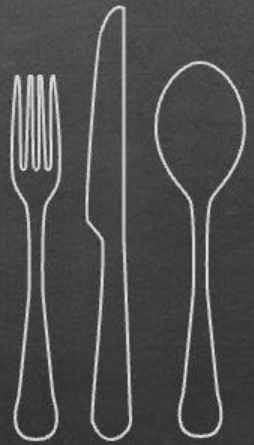
Baking products containing gluten, one of the most abundant proteins in grains (wheat, oat, and barley) may result in celiac disease and gluten sensitivity (Susanna & Prabhasankar, 2013). That is

References

Anon. (2000). American Association of Cereal Chemists. Method 66-50, 26-10A, 26.41, 66-41.

Agama-Acevedo, E., Islas-Hernandez, J. J., Osorio-Diaz, P., Rendon-Villalobos, R., Utrilla-Coello, R. G., Angulo, O. & Bello-Perez, L. A. (2009). Pasta with unripe banana flour: physical, texture, and preference study. Sensory and Food Quality, 74(6), S263-S267. http://doi.org/10.111/j.1750.3841.2009.01215.x.

۲- نقد علمی 🔍



مهم ترین نقطه قوت مقاله

می‌توان گفت این مقاله از جامعیت بالایی برخوردار است، زیرا برای محصول جدید تولیدشده، مجموعه‌ای گسترده از آزمون‌های شیمیایی، فیزیکوشیمیایی، پخت، بافت و ارزیابی‌های حسی انجام شده است.

نبود نمونه شاهد حاوی ۳ نوع آرد بدون هیدروکلوئید ها!

Table 1. The proportion of raw materials used for GF pasta samples and the control

Samples	Corn: rice: quinoa	XG (g/100g flour mixture)	B-glucan (g/100g flour mixture)
1	20:60:20	0.5	2
2		1	1.5
3		1.5	1
4		2	0.5
Control	Durum wheat flour		

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آنالیز آماری در چکیده ذکر نشده است.

ABSTRACT: The new gluten-free pasta formulations based on the ratio of corn: rice: quinoa flours (20:60:20) enriched with the different percentages (0.5, 1, 1.5, and 2%) of β-glucan and xanthan (XG) were produced to reduce the gluten-related diseases and glycemic responses. These were then compared with each other and the control (wheat flour) in terms of texture, chemical composition, rheology, color, cooking quality, sensory analysis, prebiotic activity, glucose release, rapidly and slowly digested starch (RDS and SDS), and resistant starch (RS). The highest and lowest values of loss and storage moduli were for the control and sample 1 (2% β-glucan and 0.5% XG), respectively. The control and sample 1 were also comparable in terms of textural and sensorial characteristics. The L* (brightness) of cooked and raw sample 3 reached maximum level, and the highest values of b* and a* were associated with the cooked and raw control. The superior cooking quality was related to the sample 3 (1.5% β-glucan and 1% XG) while sample with 0.5% β-glucan and 2% XG had the minimum value. Regarding functional properties, the sample 3 was the superior sample in terms of prebiotic activity, glucose release, RSD, and RS while the control showed the maximum glucose release in all digestion intervals.

پایین بودن تعداد دفعات تکرار تست ها

- ***Texture analysis of raw and cooked pasta samples***
- ***Warner-Bratzler test***

Warner-Bratzler test was applied to measure the firmness of raw and cooked samples using a Texture Analyzer (Hounsfield, H5KS, England). According to Brochard *et al.* (2021) with some modifications, pasta firmness (maximum force peak) was measured in raw or cooked form at OCT using a blade probe with different programs (speed rate (1 mm/s for raw pasta and 60 mm/min for cooked pasta), load cell (500 N), and distance or endpoint (3 mm for raw pasta and 10 mm for cooked pasta)).

- ***Texture profile analysis (TPA)***

Hardness, adhesiveness, cohesiveness, elasticity, and chewiness were measured using Texture Analyzer (6025, Instron co. England) based on the procedure of Tazrart *et al.* (2018).

- ***Statistical analysis***

All experiments were conducted at least in triple. The means, standard deviation of means, and the significant difference of mean values ($p<0.05$) for all the properties were evaluated with the one-way analysis of variance (ANOVA) and Duncan test using the SPSS.22 software.

آزمون هدونیک ۵ نقطه ای

- ***Sensory analysis***

The 5-point hedonic test was used to measure firmness, stickiness, color, and flavor of cooked pasta samples by 10 trained panelists. Scores of 1, 3, and 5 were considered extremely dislike, neither like nor dislike, and extremely like, respectively (Garbetta *et al.*, 2020).

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بازگو نکردن نوع طرح آماری

- ***Statistical analysis***

All experiments were conducted at least in triple. The means, standard deviation of means, and the significant difference of mean values ($p<0.05$) for all the properties were evaluated with the one-way analysis of variance (ANOVA) and Duncan test using the SPSS.22 software.

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یکسان بودن تمام انحراف معیارها

Table 2. Chemical composition and pH of pasta samples

Samples	Moisture content (% w/w)	Aw	Crude protein (%)	Crude fiber (%)	Ash (%)	pH
Control	11.75±0.06[a]	65.61±0.27[a]	11.48±0.07[a]	1.82±0.06[c]	0.78±0.02[c]	5.40±0.01[c]
1	10.63±0.06[d]	64.15±0.27[c]	11.72±0.07[a]	1.87±0.06[c]	0.39±0.02[d]	6.01±0.01[a]
2	11.02±0.06[b]	65.32±0.27[b]	12.30±0.07[b]	2.24±0.06[b]	0.91±0.02[a]	5.34±0.01[c]
3	10.84±0.06[c]	64.51±0.27[c]	12.53±0.07[a]	2.85±0.06[a]	0.84±0.02[b]	5.30±0.01[d]
4	9.64±0.06[e]	64.28±0.27[c]	11.97±0.07[a]	1.89±0.06c	0.40±0.02[d]	5.92±0.01[b]

Each value is the mean ± standard deviation of three replicates. In each column, different superscript letters mean significant differences ($P<0.05$).

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Table 3. Cooking quality of the control and GF pasta samples

Samples	Optimum cooking time	Weight after cooking	Cooking loss	Water adsorption capacity
Control	9.05 ± 0.19^{b}	49.35 ± 0.34^{c}	30.48 ± 0.14^{d}	23.61 ± 0.21^{b}
1	8.47 ± 0.19^{b}	50.87 ± 0.34^{b}	32.22 ± 0.14^{c}	16.93 ± 0.21^{c}
2	10.21 ± 0.19^{a}	53.12 ± 0.34^{a}	32.31 ± 0.14^{c}	23.94 ± 0.21^{ab}
3	10.34 ± 0.19^{a}	54.03 ± 0.34^{a}	34.48 ± 0.14^{a}	24.56 ± 0.21^{a}
4	8.73 ± 0.19^{b}	49.75 ± 0.34^{c}	33.59 ± 0.14^{b}	15.94 ± 0.21^{d}

Each value is the mean ± standard deviation of three replicates. In each column, different superscript letters mean significant differences ($P<0.05$).

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Table 5. Prebiotic activity and glucose release and different starch fractions of pasta samples

Samples	Prebiotic activity Log cfu/ml	Glucose release at 20 min	Glucose release at 120 min	RDS	SDS	RS
Control	7.47±0.08^{b}	55.60±2.55^{a}	93.65±0.61^{a}	52.74±0.87^{a}	31.55±0.78^{b}	15.72±0.55^{c}
1	7.20±0.08^{c}	55.57±2.55^{a}	91.69±0.61^{a}	50.01±0.87^{a}	32.52±0.78^{ab}	17.48±0.55^{c}
2	7.50±0.08^{b}	36.39±2.55^{b}	77.41±0.61^{b}	34.44±0.87^{b}	35.23±0.78^{a}	30.34±0.55^{b}
3	7.92±0.08^{a}	26.77±2.55^{c}	65.32±0.61^{c}	25.26±0.87^{c}	33.53±0.78^{ab}	41.21±0.55^{a}
4	7.20±0.08^{c}	36.88±2.55^{b}	65.32±0.61^{c}	34.94±0.87^{b}	24.26±0.78^{c}	40.80±0.55^{a}

ذکر برخی اعداد یا داده ها!

- ***Color analysis***

The color factors (L*, a*, and b*) of raw and cooked pasta samples have been shown in Figure 2. The color of samples was significantly different one another ($p<0.05$). Among cooked pasta samples, sample 3 had the highest brightness (L*) while the control and sample 4 had the lowest one. Also, the highest amount of redness (a*) and yellowness (b*) was related to the control.

sample 2 (1.5% b-glucan and 1% XG) had the highest level of Ash. The crude fiber in GF samples was more than that of the control, and sample 2 and 3 showed the highest values of crude fiber. pH also ranged from 5.30 (sample 3) to 6.01 (sample 1). It demonstrated that different percentage of hydrocolloids present in pasta sample can affect the chemical analysis (De Paula *et al*., 2017).

نقاط قوت:

(cooked or raw) ($p<0.05$). In general, firmness of raw pasta was higher than that of cooked pasta (no shown statistically). It is related to greater water absorption of the cooked pasta samples (Brochard *et al.*, 2021) and weaker protein network during cooking (Makdouk & Rosentrater, 2017).

(Gupta *et al.*, 2021). Likewise, cooking and processing can affect all the color factors due to the oxidation of carotenoids present in the pasta samples (Krawecka *et al.*, 2020).

ذکر ناقص دلیل و عدم بحث کافی!

Moreover, the control needed higher strain force to be cut than the GF samples. It was because of the formation of more rigid network by gluten (Brochard *et al*., 2021). In cooked pasta samples, the highest level

sample 2 (1.5% b-glucan and 1% XG) had the highest level of Ash. The crude fiber in GF samples was more than that of the control, and sample 2 and 3 showed the highest values of crude fiber. pH also ranged from 5.30 (sample 3) to 6.01 (sample 1). It demonstrated that different percentage of hydrocolloids present in pasta sample can affect the chemical analysis (De Paula *et al*., 2017).

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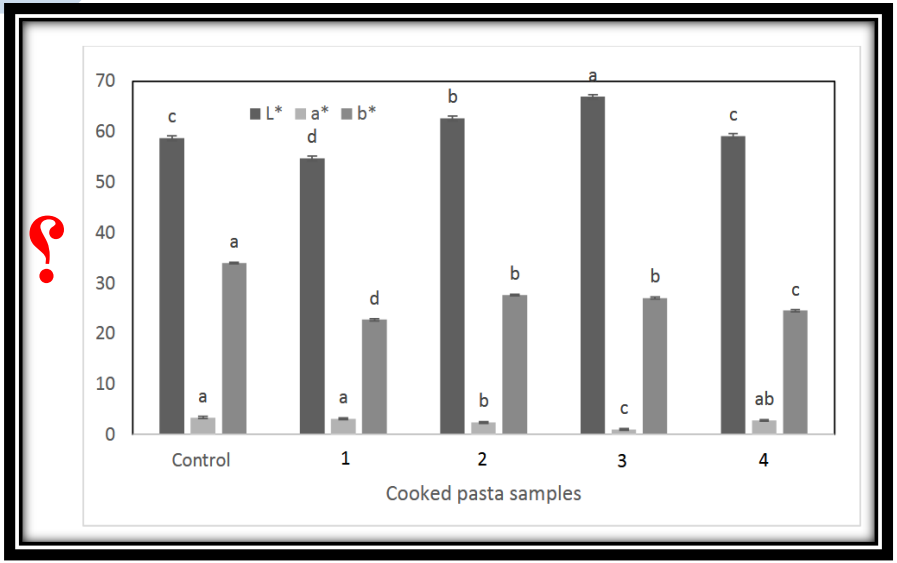

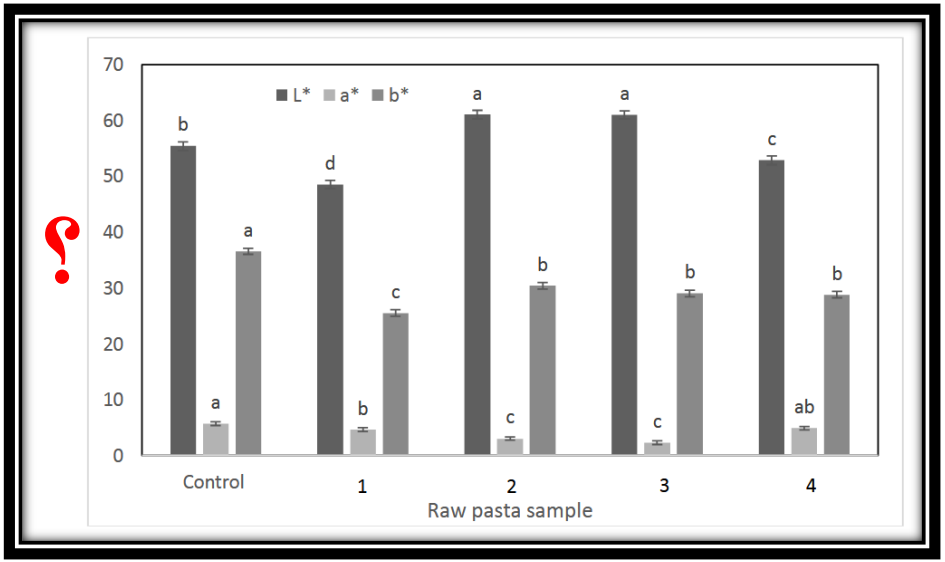

Fig. 2. The color factor of cooked and raw pasta samples.

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Table 4. The textural parameters of pasta samples with TPA test

Samples	Hardness	Adhesiveness	Cohesiveness	Elasticity	Chewiness
Control	42.20±1.34^{a}	1.11±0.00^{a}	0.66±0.02^{a}	0.69±0.18^{a}	17.44±0.87^{a}
1	40.56±1.51^{a}	0.97±0.03^{b}	0.66±0.02^{a}	0.62±0.07^{ab}	16.69±2.74^{a}
2	30.44±0.36^{c}	0.82±0.00^{c}	0.45±0.01^{c}	0.51±0.02^{b}	7.08±0.06^{c}
3	32.29±0.26^{b}	0.84±0.01^{c}	0.47±0.02^{c}	0.45±0.01^{b}	6.94±0.15^{c}
4	33.24±0.56^{b}	0.82±0.03^{c}	0.57±0.02^{b}	0.62±0.05^{ab}	11.66±1.12^{b}

Each value is the mean ± standard deviation of three replicates. In each column, different superscript letters mean significant differences ($P<0.05$).

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