



## Letter to the Editor

## Consumption of 'gofio', a roasted cereal flour from the Canary Islands, is associated with exercise capacity and risk of coronary heart disease in the elderly



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Epidemiological evidence supports that diets high in whole grain foods decrease risks associated with chronic diseases including coronary heart disease (CHD), obesity, and type 2 diabetes [1]. Whole grain intake can also be linked to biomarkers of disease risk, including an inverse association of whole grain intake to incident hypertension [2].

In the Canary Islands (Spain), cereal consumption traditionally consists of eating 'gofio' [3]. Grain is of important historical significance to the Canary Islands because it has been a staple food source for many centuries. 'Gofio' is obtained from a combination of cereals (mainly maize and wheat) that are roasted, stone-ground and mixed in variable proportions (Table 1) [4]. This food is so important in the Canary Islands that their Agricultural and Food Council, at the request of the Canary Island Association of Gofio Makers, have protected designations of origin, geographical indications for agricultural and food products as a way to protect the different features of this agri-food and that it is produced in accordance with pre-Hispanic tradition throughout the Island.

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Through this, the Council acknowledges its high energy content and excellent digestibility [5].

To date, it is unknown whether the consumption of 'gofio' has any cardiovascular properties in the elderly. Therefore, the aim of this study is to assess whether the intake of 'gofio' has any influence in the risk of CHD or exercise capacity in the elderly.

This prospective study included a group of 1358 consecutive outpatient and elderly patients with symptoms of chest pain, who were referred to exercise treadmill testing (ETT) at a tertiary hospital. The exclusion criteria of the present study were: patients with known CHD, history of revascularization, presence of significant valvular disease, previous diagnosis of congestive heart failure, evidence of lung disease and previous pacemaker implantation. Hence, 1004 subjects were analyzed. The study complies with the Declaration of Helsinki; the research protocol was approved by the local ethics committee. All participants signed written informed consent before entry to the study.

All subjects completed a graded ETT limited by symptoms according to a standard Bruce protocol. Significant ST-segment depression (defined as  $\geq 1.0$  mm of horizontal or downsloping depression or  $\geq 1.5$  mm of upsloping depression at 60 ms after the J point) with ETT was considered diagnostic for ischemia [6]. Coronary angiography was performed by conventional technique in those subjects who showed ischemia in ETT as the 'gold standard' procedure for CHD detection.

The patients were asked to report their 'gofio' intake for breakfast. The intake of 'gofio' was based on a daily intake of 30 g/day for over 40 years. Moreover, a 14-item dietary screener was used to assess adherence to the MeDiet at baseline [7]. This questionnaire consisted of 14 dichotomous questions on food consumption frequency. The final score thus ranged from 0 to 14 points. This questionnaire classified baseline adherence to the MeDiet categorized as: low adherence (score 3–9), moderate adherence (score 10–11) and high adherence (score 12–14) [7].

Results for normally distributed continuous variables are expressed as the mean value + standard deviation, and continuous variables with non-normal distribution are presented as median values (interquartile intervals). Analysis of normality of the continuous variables was performed using the Kolmogorov–Smirnov test. For the purpose

**Table 1**  
Nutritional characteristics of 'gofio'.

Compound	Content in 100 g	Content in 30 g (1 ration)
Humidity	3.87	1.16
Proteins	10.23	3.1
Total sugars	0.86	0.26
Starch	81.3	24.4
Ashes	2.07	0.62
Dietetic fiber	11.78	3.53
Fat	2.74	0.82
Palmitic acid	13.48	4.04
Myristic acid	0.21	0.06
Oleic acid	22.43	6.73
Stearic acid	1.44	0.43
Linoleic acid	58.66	17.60
(Linolenic + eicosanoic) acids	3.80	1.14
Sodium	0.38	0.114
Potassium	0.36	0.108
Iron	3.40	1.020
Zinc	1.84	0.552
Magnesium	0.11	0.033
Calcium	33.34	10.00
Copper	<2	–
Phosphorus	170	51.0

of the analysis, patients were divided into Group A (patients with 'gofio' intake) and Group B (patients without 'gofio' intake). Logistic regression was used to assess the univariate associations between continuous baseline characteristics and 'gofio' intake/negative exercise test result, and  $\chi^2$  testing was used for discrete variables. We assessed independent predictors of a negative result in the exercise test using a binary logistic regression analysis. Logistic regression analysis parameters were obtained through the Wald test. Backward stepwise selection was used in all multivariate models to derive the final model for which significance levels of 0.1 and 0.05 were chosen to exclude and include terms, respectively. Differences were considered to be statistically significant if the null hypothesis could be rejected with .95% confidence. The SPSS 20.0 statistical software package (SPSS Inc., Chicago, IL, USA) was used for all calculations.

The demographic characteristics and clinical data of the 1004 participants classified according to 'gofio' intake are summarized in Table 2. Male gender proportion in group A was higher compared to group B. There were no significant differences between the groups in regard to the presence of conventional coronary risk factors for CHD, MedDiet adherence score and medications. Of the 1004 subjects, 296 (29.5%) had positive ETT results. Patients in Group B had more positive ETT results as well as a higher rate of CHD when compared with Group A. In contrast, levels of exercise capacity were higher in Group A compared to Group B.

Baseline characteristics of the subjects included in the study according to the ETT results are presented in Table 3. There were no significant differences between groups in regard to age, sex, coronary risk factor and MedDiet adherence score. However, significant differences were found between both groups with respect to beta blocker intake. Multivariate analysis adjusting for the potential confounder, showed that the 'gofio' intake (OR: 1.7, 95% CI: 1.3–2.3,  $P < 0.001$ ) was an independent predictor of negative ETT.

The most important and interesting find of this study was that in a large group of elderly subjects the 'gofio' intake was associated with negative ETT results and increased exercise capacity. This association was robust and independent of several known coronary risk factors, aside from the inclusion of MedDiet adherence score.

The inverse association between CHD risk and whole grain intake could be due to beneficial effects on serum lipid metabolism, glucose and insulin metabolism, and blood pressure [8]. Grains that consist of bran, germ, and endosperm components, when refined, carbohydrate rich endosperm component is retained, while many biologically active agents, such as fiber, vitamins, minerals, antioxidants, and other plant

**Table 2**  
Basal characteristics of the 1004 patients classified according to 'gofio' intake.

	Group A 'Gofio' intake (n = 597)	Group B Absence of 'Gofio' intake (n = 407)	P value
Age, years	75.5 ± 2.6	75.7 ± 2.6	0.23
Male gender, n (%)	445 (74.5)	278 (68.3)	0.03
<i>Cardiovascular risk factors</i>			
Hypertension, n (%)	385 (64.5)	244 (60)	0.14
Smoking habit, n (%)	147 (24.6)	93 (22.9)	0.5
Dyslipidemia, n (%)	337 (56.4)	235 (57.7)	0.7
Diabetes mellitus, n (%)	256 (42.9)	172 (42.3)	0.8
<i>Mediterranean diet adherence score</i>			
Low adherence (score 3–9)	41 (6.8)	16 (3.9)	0.06
Moderate adherence (score 10–11)	207 (34.7)	162 (39.8)	
High adherence (score 12–14)	349 (58.5)	229 (56.3)	
<i>Medications</i>			
Beta blockers, n (%)	97 (16.2)	54 (13.3)	0.2
Calcium channel antagonists, n (%)	33 (5.5)	27 (6.6)	0.5
ACE <sup>a</sup> inhibitors/ARB <sup>b</sup> , n (%)	221 (37)	144 (35.4)	0.6
Diuretics, n (%)	110 (18.4)	58 (14.3)	0.08
Statins, n (%)	337 (56.4)	235 (57.7)	0.7
Antidiabetic medication, n (%)	256 (42.9)	172 (42.3)	0.8
<i>Exercise test</i>			
Positive, n (%)	147 (24.6)	149 (36.6)	<0.001
METS, units	6.7 ± 1.1	6.4 ± 1.1	<0.001
<i>Coronary angiogram</i>			
Without indication, n (%)	450 (75.4)	258 (63.4)	<0.001
Without obstructive CHD <sup>c</sup> , n (%)	76 (12.7)	82 (20.1)	
Significant CHD <sup>c</sup> , n (%)	71 (11.9)	67 (16.5)	

<sup>a</sup> ACE: angiotensin-converting-enzyme.

<sup>b</sup> ARB: angiotensin II receptor antagonist.

<sup>c</sup> CHD: coronary heart disease.

compounds (lignans, phytosterols, etc.) are removed with the bran and germ [9]. These biological agents influence cardiovascular risk through effects on glucose homeostasis, lipids and lipoproteins, endothelial function,

**Table 3**  
Basal characteristics of the 1004 patients classified according to the ETT<sup>a</sup> result.

	Positive ETT <sup>a</sup> (n = 296)	Negative ETT <sup>a</sup> (n = 708)	P value
Age, years	75.8 ± 2.5	75.5 ± 2.7	0.6
Male gender, n (%)	220 (74.3)	503 (71)	0.3
<i>Cardiovascular risk factors</i>			
Hypertension, n (%)	189 (63.9)	440 (62.1)	0.6
Smoking habit, n (%)	82 (27.7)	158 (22.3)	0.07
Dyslipidemia, n (%)	169 (57.1)	403 (56.9)	0.9
Diabetes mellitus, n (%)	128 (43.2)	300 (42.3)	0.8
'Gofio' intake	147 (49.7)	450 (63.6)	<0.0001
<i>Mediterranean diet adherence score</i>			
Low adherence (score 3–9)	16 (5.4)	41 (5.8)	0.8
Moderate adherence (score 10–11)	105 (35.5)	264 (37.3)	
High adherence (score 12–14)	175 (59.1)	403 (56.9)	
<i>Medications</i>			
Beta blockers, n (%)	31 (10.5)	120 (16.9)	0.009
Calcium channel antagonists, n (%)	20 (6.8)	40 (5.6)	0.5
ACE <sup>b</sup> inhibitors/ARB <sup>c</sup> , n (%)	112 (37.8)	253 (35.7)	0.5
Diuretics, n (%)	56 (18.9)	112 (15.8)	0.23
Statins, n (%)	169 (57.1)	403 (56.9)	0.9
Antidiabetic medication, n (%)	128 (43.2)	300 (42.4)	0.8
<i>Coronary angiogram</i>			
With obstructive CHD <sup>d</sup> , n (%)	158 (53.4)	–	
Significant CHD <sup>d</sup> , n (%)	138 (46.6)	–	

<sup>a</sup> ETT: exercise treadmill testing.

<sup>b</sup> ACE: angiotensin-converting-enzyme.

<sup>c</sup> ARB: angiotensin II receptor antagonist.

<sup>d</sup> CHD: coronary heart disease.

and other mechanisms, potentially accounting for much of the observed benefit of high intake of whole grains [9].

'Gofio' is characterized as a foodstuff with high nutritional value rich in minerals, especially iron, zinc and magnesium. Moreover, it is a food low in calories (366 cal per 100 g of roasted cereal flours) [10]. Most vitamins and minerals are lost during the production process of white flour; specifically the decortication grains where most of the nutrients are stored. However, 'gofio' is obtained from whole grain which avoids this loss in vitamins and minerals [5].

In our study, the group who consumed 'gofio' had lower proportions of CHD. Whole grain constituents also appear to influence the vascular endothelium directly. The intake of whole grains rich in lignans and phytoestrogens has been associated with decreased cardiovascular death [9], presumably through beneficial effects on the endothelium. We must emphasize that the levels of fat-soluble and water-soluble vitamins in the 'gofio' are significant, despite losses caused during the process of roasting [3,5].

The strengths of our study include the population-based prospective design, and the availability of detailed information on a wide range of potential confounders. The diagnosis of CHD was verified through the performance of cardiac catheterism in patients with ischemia in the ETT. Limitations of this study include the lack of multiple measurements of dietary variables.

This is the first study to directly assess cardiovascular properties of 'gofio' intake. The results suggest that in elderly patients, the consumption of 'gofio' is associated with increased exercise capacity and reduced risk of CHD.

#### Conflict of interest

The authors report no relationships that could be construed as a conflict of interest.

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#### References

- [1] K. Hristova, I. Shiuie, D. Pella, et al., Prevention strategies for cardiovascular diseases and diabetes mellitus in developing countries: World Conference of Clinical Nutrition 2013, *Nutrition* 30 (2014) 1085–1089.
- [2] Z. Asemi, M. Samimi, Z. Tabassi, H. Shakeri, S.S. Sabihi, A. Esmailzadeh, Effects of DASH diet on lipid profiles and biomarkers of oxidative stress in overweight and obese women with polycystic ovary syndrome: a randomized clinical trial, *Nutrition* 30 (2014) 1287–1293.
- [3] J.M. Caballero, R.L. Tejera, A.A. Caballero, et al., Mineral composition of different types of Canarian gofio; factors affecting the presence of Na, K, Mg, Ca, Mn, Fe, Cn and Zn, *Nutr. Hosp.* 29 (2014) 687–694.
- [4] J.M. Caballero Mesa, S. Alonso Marrero, D.M. González Weller, V.L. Afonso Gutiérrez, C. Rubio Armendariz, A. Hardisson de la Torre, Implementation and evaluation of critical hazards and check points analysis (CHCPA) in gofio-producing industries from Tenerife, *Nutr. Hosp.* 21 (2006) 189–198.
- [5] O.M. Hernández, J.M. Fraga, A.I. Jiménez, F. Jiménez, J.J. Arias, Characterization of toasted cereal flours from the Canary Islands (gofios), *Food Chem.* 151 (2014) 133–140.
- [6] M.P. Christman, M.S. Bittencourt, E. Hulthen, et al., Yield of downstream tests after exercise treadmill testing: a prospective cohort study, *J. Am. Coll. Cardiol.* 63 (2014) 1264–1274.
- [7] M.A. Martínez-González, E. Fernández-Jarne, M. Serrano-Martínez, M. Wright, E. Gomez-Gracia, Development of a short dietary intake questionnaire for the quantitative estimation of adherence to a cardioprotective Mediterranean diet, *Eur. J. Clin. Nutr.* 58 (2004) 1550–1552.
- [8] P.B. Mellen, T.F. Walsh, D.M. Herrington, Whole grain intake and cardiovascular disease: a meta-analysis, *Nutr. Metab. Cardiovasc. Dis.* 18 (2008) 283–290.
- [9] J. Slavin, Why whole grains are protective: biological mechanisms, *Proc. Nutr. Soc.* 62 (2003) 129–134.
- [10] O. Cerpa, R. Millán, E. Sanjuán, L. Tudela, Contribución al estudio de las características nutricionales, físico-químicas y organolépticas del gofio canario, *Alimentaria* 322 (2001) 119–123.