

Beverages have an appreciable contribution to the intake of soluble dietary fibre: a study in the Spanish diet.

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9 **Abstract**

10 Beverages are generally not taken into account to determine the intakes of dietary fibre
11 in diets. Soluble dietary fibre content was determined in common alcoholic and non
12 alcoholic beverages - ranging from 0.18g/L in white wine to 9.01 g/L in instant coffee
13 - and their contribution to the dietary fibre intake in the Spanish Mediterranean diet was
14 estimated at 2.13g/person/day. It is concluded that beverages provide an appreciable
15 amount of soluble dietary fibre in the diet, and the omission of its contribution may
16 lead to underestimate dietary fibre intakes.

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18 **Keywords:** dietary fibre, dietary intake, beverages, polysaccharides, soluble dietary
19 fibre, Mediterranean diet.

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24 **1. Introduction**

25 The literature and food composition tables provide comprehensive dietary fibre (DF)
26 data on plant foods (Food Standards Agency 2004; Moreiras et al. 2007), but they
27 generally report zero DF content for beverages because of analytical methodology
28 limitations (Mañas et al. 1994). The intake of dietary fibre in diets is determined
29 exclusively from vegetable food data because it is generally assumed that beverages do
30 not contain dietary fibre. However, the processing of plant foods to obtain common
31 beverages may solubilize an appreciable amount of soluble indigestible polysaccharides
32 or dietary fibre (Diaz-Rubio & Saura-Calixto 2009; Diaz-Rubio & Saura-Calixto 2006;
33 Diaz-Rubio & Saura-Calixto 2007). Dietary fibre intakes (determined from solid plant
34 food data) are estimated at around 20 g/person/day in Western countries, which is
35 below the recommended allowances (25-35 g or 14g/1000 Kcal) (Buttriss & Stokes,
36 2008; Lunn & Buttriss, 2007). To our knowledge there are no studies on the
37 contribution of beverages to DF intakes. The aim of this work was to determine soluble
38 dietary fibre (SDF) in the most common beverages and to estimate their contribution to
39 the intake of dietary fibre in a whole diet – in this case the Spanish Mediterranean diet.

40 **2. Material and methods**

41 Individual beverages selected in this study (juices, alcoholic beverages, coffee,
42 infusions, soft drinks and others) are representative of drinks most common in the
43 Spanish market (MAPA 2009). The method for SDF determination has been previously
44 reported (Diaz-Rubio & Saura-Calixto 2006; Diaz-Rubio & Saura-Calixto 2007). A
45 simplified scheme of the methodology is shown in Figure 1. Calibration curves from
46 monosaccharides profile (Figure 2) of the hydrolysed dietary fibre component of each
47 beverage (obtained by gas-liquid chromatography analysis) were used to quantify SDF.

48 **3. Results and Discussion.**

49 The contents of SDF in fruit juices, alcoholic drinks, coffee and infusions and soft
50 drinks are shown in table I. The beverages tested in this work, with the exception of soft
51 drinks that present a negligible content, have an appreciable SDF amount, ranging from
52 0.18g/L in white wine to 9.01 g/L in instant coffee .

53 In the alcoholic beverage group, beer and red wine had higher SDF contents (2.08g/L
54 and 1.91 g/L) than drinks such as cider (0.23g/L) and white wine (0.18g/L) which are
55 elaborated without maceration, the lack of which dramatically limit the solubilisation of
56 fibre. Instant or soluble coffee (freeze-dried coffee infusion) (9.01 g/L) and cocoa drink
57 (7.36 g/L) showed the highest SDF content (table I).

58 Spirits and drinks obtained by distillation do not contain SDF. As it was expected, soft
59 drinks showed a negligible amount of SDF probably coming from some additive; only
60 orange soft drink contained a certain amount of SDF (0.24g/l).

61 Figure 2 shows the monomer composition of SDF, which represent their main
62 polysaccharides . For instance, mannose (32.19%) and galactose (27.15%) were the
63 main monosaccharides found in red wine, suggesting that arabinogalactan and
64 mannans are the most important SDF components. On the other hand the presence of
65 fucose in apple juice could indicate that fucogalactoxyloglucane is part of the SDF in
66 this juice (Schols et al. 1995) (figure 2). Different amount of uronic acids were found in
67 the beverages; the highest amount were detected in juices, which accord with the well
68 known richness of pectin and acidic polysaccharides content in raw fruits (Sila et
69 al.2009)

70 Beverages consumption and dietary fibre intake in Spanish Mediterranean diet are listed
71 in table II. Around 630 mL of beverages are daily per capita consumed in the Spanish
72 diet, corresponding around 36 % to alcoholic drinks. Lager beer, espresso coffee, cocoa
73 milk and wine are the individual items most consumed. Beverages provide a total

74 amount of 2.13 g/person/day of SDF in the Spanish diet, contributing significantly to
75 the intake of DF. The intake of DF from solid vegetable food in the Spanish diet was
76 estimated at 18.2 g (Saura-Calixto & Goñi, 2004), corresponding to 6.9 g of SDF. The
77 present work raises the intake of SDF from 6.9 g to 8.4g, which represents an increase
78 of 25% in total soluble DF and an increase of 10.4% of the total DF intake (Fig.3).
79 The contribution of beverages to the intake of SDF is of the same order than other plant
80 food groups such as fruits, beverages and cereals and higher than nuts and legumes.
81 The consumption of beverages for the adult population can be expected to be higher
82 than the per capita data indicated in table II, which include elderly people and children.
83 For example, a typical adult consuming 2 coffees (100mL), 1 pint of beer (500mL), and
84 an apple juice (250mL) per day has an intake around 2.5 g of SDF from these drinks,
85 which is an important amount in terms of accounting for total intake of DF. In
86 summary, beverages common in the diet contain appreciable amount of soluble dietary
87 fibre contributing significantly to the intake of DF. They may have a significant role in
88 the health effects associated to DF intake.

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147 **Tables**148 Table I. Content of soluble dietary fibre (SDF) in beverages^a

	Type of beverage	UA (g/L)^b	NS(g/L)^c	SDF (g/L)
Juices	Apple	0.53±0.01	0.57±0.01	1.10 ±0.01
	Commercial orange	0.10±0.01	1.17±0.01	1.27±0.01
	Orange	0.14±0.01	2.23±0.02	2.37±0.02
	Orange and soy	1.11±0.01	1.25±0.08	2.36±0.08
	Pineapple	0.04 ±0.01	0.74±0.07	0.79±0.07
	Pineapple and grape	0.06±0.01	0.43±0.01	0.49±0.01
	Peach	0.53±0.01	2.29±0.06	2.82±0.06
	Peach and grape	0.41±0.01	2.23±0.02	2.64±0.02
	Grape	0.09±0.01	0.27±0.01	0.36±0.01
	Tomato	1.78±0.01	2.98±0.1	4.76±0.1
Alcoholic Beverages	Red wine	0.17±0.01	1.74±0.01	1.91±0.01
	White wine	0.06±0.001	0.12±0.001	0.18±0.002
	Cider	0.01±0.001	0.22±0.01	0.23±0.01
	Alcohol free beer	0.03±0.001	1.06±0.06	1.09±0.06
	Lager beer	0.03±0.001	2.05±0.05	2.08±0.04
	Dark Beer	0.03±0.001	3.51±0.02	3.54±0.02
Coffee and Infusions	Red tea	0.06±0.003	1.07±0.05	1.13±0.05
	Instant coffee	0.02±0.004	8.99±0.4	9.01±0.40
	Espresso coffee	0.01±0.004	8.30±0.30	8.32±0.30
	Filter coffee	0.09±0.003	5.26±0.07	6.01±0.07
	Mint tea	negligible	0.16±0.02	0.16±0.02
	Camomile tea	0.07±0.001	0.01±0.01	0.08±0.01
Soft drinks and others	Coke	negligible	negligible	negligible
	Isotonic drink	negligible	negligible	negligible
	Tonic water	negligible	negligible	negligible
	Orange drink	0.11±0.02	0.13±0.04	0.24±0.04
	Tigger nut milk	negligible	1.50±0.09	1.50±0.09
	Cocoa milk drink	0.15±0.04	7.22±0.2	7.36±0.2

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150 ^a Results are expressed as mean values ± standard deviation. Comparison of means of three
151 measurements, using a significance level of p<0.05, was performed by one-way analysis of
152 variance (ANOVA) using the Statgraphics Computer System, version 5.1.

153 ^b Uronic acids. ^c Neutral sugars.

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155 Table II. Consumption of beverages and intake of soluble dietary fibre (SDF) in the
 156 Spanish Mediterranean diet
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Type of beverage		Consumption ^a (ml/person/day)	SDF (g/person/day)
Juices	Comercial Orange	10.55	0.013
	Pineapple	10.67	0.030
	Peach	8.55	0.070
	Others^b	14.48	0.020
Alcoholic Beverages	Alcohol free beer	30.81	0.033
	Lager beer	126.01	0.260
	White wine	13.28	0.002
	Red wine	32.6	0.062
	Others^c	24.79	0.021
Coffee and Infusions	Instant coffee	22	0.198
	Espresso coffee	81	0.670
	Filtered coffee	20	0.110
	Tea and others^d	20	0.002
Soft drinks and others	Cocoa milk drink	85.01	0.620
	Orange drink	35.1	0.008
	Others^e	98.15	0.009
TOTAL		633	2.1284

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159 ^a Spanish National food consumption data (MAPA, 2009).

160 ^b Total consumption and SDF mean value of juices : apple, natural orange, orange and soy,
 161 pineapple and grape , peach and grape, tomato .

162 ^c Total consumption and SDF mean value of dark beer, alcohol-free beer and natural cider.

163 ^d Total consumption and SDF mean value of red tea, mint tea, chamomile tea

164 ^e Total consumption and SDF mean value of tiger nut and soft drinks.

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169 **Figures Captions**

170 Figure 1. Schematic procedure for dietary fibre determination in beverages and liquid
171 samples.

172 Figure 2. Neutral sugars composition of selected beverages analyzed in the hydrolysates
173 by gas-liquid chromatography.

174 Figure 3. Contribution of beverages to the intake of soluble dietary fibre in the Spanish
175 Mediterranean diet.

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192 **Figures.**

193 Figure 1. Schematic procedure

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214 ^a Except for infusions, cocoa drink and coffee.

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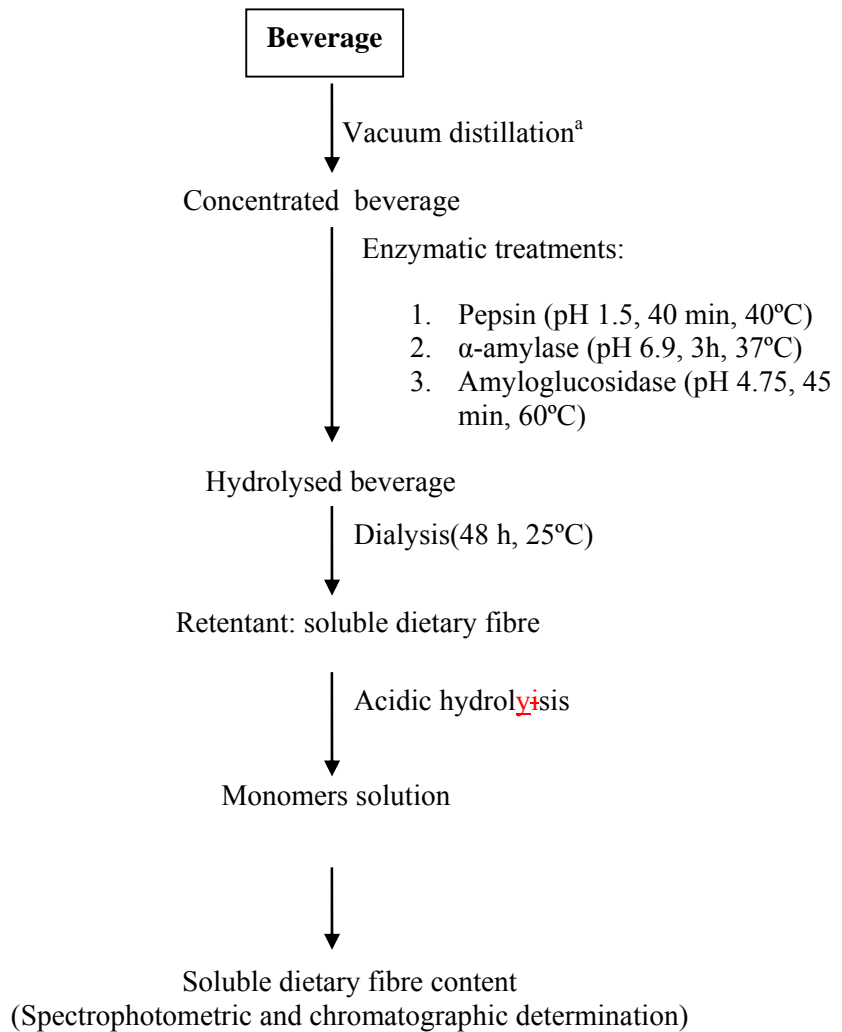
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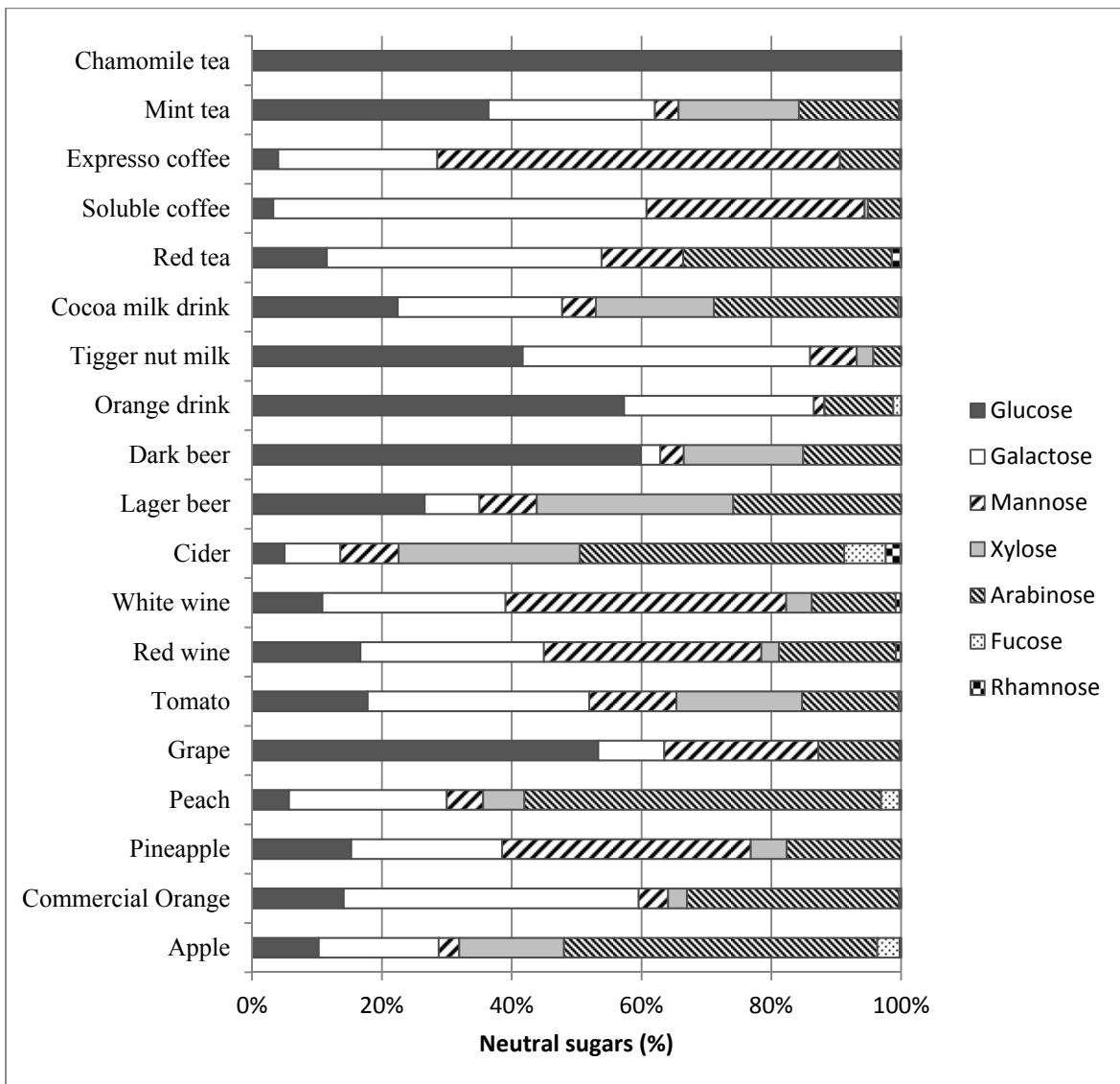
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221 | Figure 2. Neutral sugar composition of dietary fibre component of selected beverages



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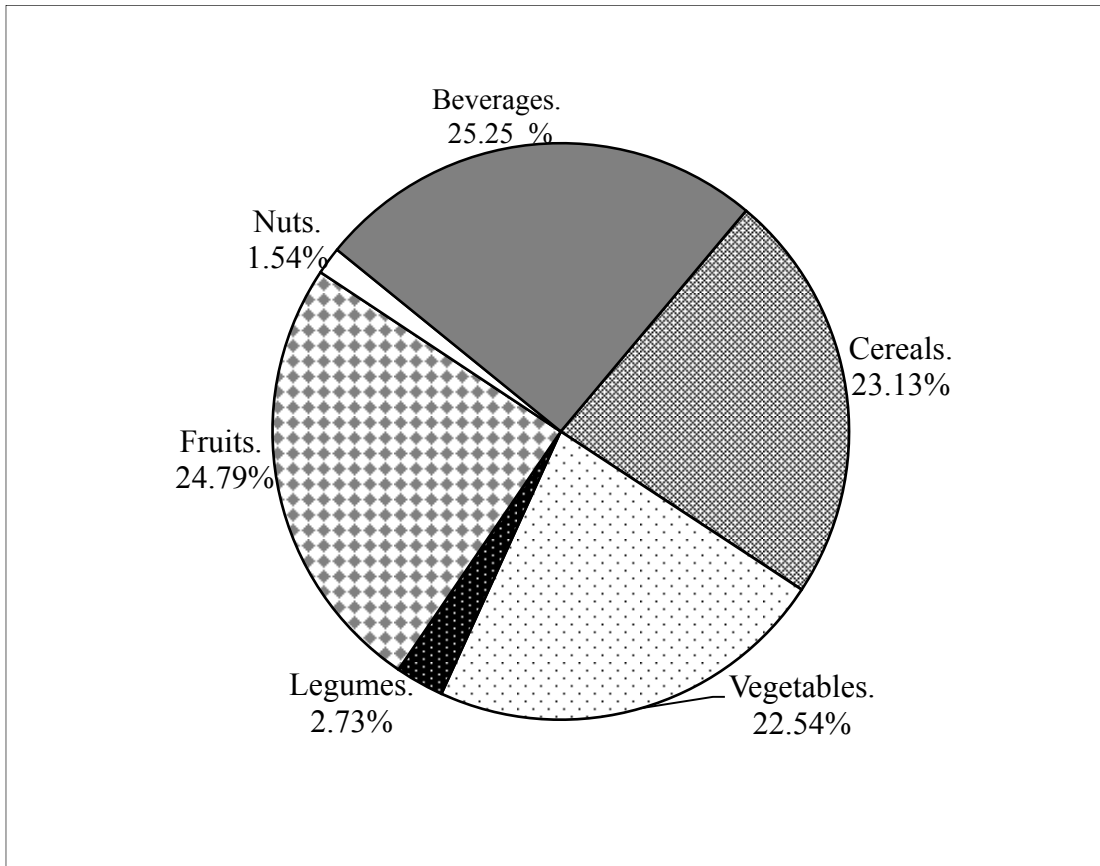
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232 Figure 3. Contribution of plant food and beverages to the intake of SDF in Spanish diet^a

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236 ^aData were taken from Saura-Calixto & Goñi (2004) and Spanish National food
237 consumption data (MAPA,2009).

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