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Comparative Study of Commercial Dried Fruits on Labeling Information, Chemical Parameters, Antioxidant Capacity and Sensory Profile †

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Abstract: Manufacturers have been deeply involved in increasing the variety of dried fruits available in the market following consumers demand for healthy foods. It is essential to highlight that there is no daily recommend intake of dried fruits. The aim of the present study was to compare the labeling information, chemical parameters, antioxidant capacity and sensory profile among: (i) different dried fruits (apple, mango, pineapple, tomato, fig, coconut, banana and red cranberry) and, (ii) different commercial brands for each dried fruit (n = 3). Depending on the fruit, labelling information were unevenly adhered to "*clean label trend*". Preservatives were present when water activity could favor microbial spoilage or product deterioration. Among commercial brands, significant differences (p-value < 0.05) on antioxidant capacity, organic acid profile, sugar profile, and sensory attributes (texture, fruity, basic tastes) were found. As to nutritional quality, it is essential to highlight that a high content of sugars (labelling information) was found in all samples (75% of samples more than 25 g/100 g). On the other hand, a high content of fiber (labelling information) was found (>10 g/100 g) in dried coconut, apple and tomato samples.

Keywords: dehydrated; nutritional; quality

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1. Introduction

Drying is an ancient and unparalleled physical procedure of food preservation used for direct preparation of food products as well as for further processing in the food industry. The quality of dehydrated fruits is a key issue closely related to the development and optimization of novel drying techniques. Nutritional, functional, flavor and texture properties are modified, obtaining a new generation of products such as snacks that can be an alternative to other commercial products [1]. For these reasons, the food industry supports the research in both quality characteristics and processing techniques.

Nowadays, the concept of "*Clean Label*" is a priority for food and beverage companies, but it is an unregulated and undefined descriptor. Due to the lack of legal definitions and specific regulations, the interpretation of "*Clean Label*" is subjective both to consumers and food companies. It does not exist a specific place in the supermarket dedicated to clean-label foods, and it is also not seen the words "*Clean Label*" on the product label. What is clear is that most of the definitions agree that it must contain a short and simple ingredient list, and words such as natural, organic, or free from additives. On the other hand, words that sound like chemicals or E-numbers must be avoided [2].

The aim of the present study was to compare the labeling information ("*clean label*" trend), chemical parameters, antioxidant capacity and sensory profile among: (i) different

dried fruits (n = 8: apple, mango, pineapple, tomato, fig, coconut, banana and cranberry) and, (ii) different commercial brand of each type of dried fruits (n = 3).

2. Materials and Methods

2.1. Commercial Dried Fruits

Samples were different dried fruits (n = 8): apple, mango, pineapple, tomato, fig, coconut, banana and cranberry were included. Different commercial brands (n = 3) of each type of fruit and three bags of each one were purchased at local supermarkets from Alicante province (Spain). If available each bag belonging to a different batch. Each value is the mean of three independent bags/batches. Table 1 shows the list of the samples, the ingredients and the claims included on their labels.

Table 1. Ingredients list and claims in commercial dried fruits.

	Brand	INGREDIENTS	CLAIMS
Apple	1	Apple without additives and no-added sugar	Vegan, no added sugars
	2	Apple only, no added sugar	High fiber content, dehydrated fruit without frying, no dyes or preservatives
	3	Apple 100%	100% natural, source of fibers, without preservatives, without added sugars
Mango	1	Mango and preservative (E-220). Contains sulfites	-
	2	Mango (99.6%), Rice flour (0.4%), antioxidant (sulfites)	High fiber, K content, source of vitamin C and D, no fried, Vegan, and no-added sugar
	3	Organic sliced mango	-
Pinneaple	1	Dehydrated pineapple	No added sugars, it contains naturally present sugars
	2	Pineapple (99.6%), Pineapple flour (0.4%), antioxidant (sulfites)	High content of fiber, not fried, vegan, no added sugar, source of calcium, vitamin C, vitamin D and K
	3	Dehydrated pineapple	No added sugars, contains naturally present sugars
Tomato	1	Tomato	No added salt, vegan, gluten free
	2	Tomato and salt	Vegan, no sulfites
	3	Dried tomatoes and salt	-
Fig	1	Dried figs and rice flour from controlled organic farming	-
	2	Dried figs and rice flour	Gluten Free 100% natural
	3	Dried figs and rice flour	Gluten Free
Coconut	1	Dried and laminated coconut	Gluten Free
	2	Coconut only (dehydrated)	No added sugar, sugars naturally present, high fiber content, no dyes or preservatives, no-fried
	3	Dehydrated nucifera coconut chips with organic certification	-
Banana	1	Banana, coconut oil, sugar (10%) and aroma	-
	2	60% Banana (*Musa paradisiaca)* dehydrated, 30% coconut oil, 10% sugar cane,	Organic certification
	3	Sliced dried banana (Philippines), coconut vegetable oil, sugar, banana aroma	-
Cranberry	1	Cranberries (60%), cane sugar (39%) and sunflower oil (<1%).	Vegan product, gluten free. It comes from organic farming
	2	Blueberries, sugar and sunflower oil	-
	3	60% cranberries, sugar, sunflower oil	Natural product

2.2. Labelling

Review compliance with current food legislation: Regulation (UE) N° 1169/2011, Regulation (CE) N° 1924/2006, and Regulation (UE) N° 432/2012. Also, organic certification (Regulation (UE) N° 1169/2011) and gluten-free regulation (Regulation (UE) N° 828/2014) was revised.

2.3. Methodology

Water activity was obtained using Aw sprint TH-500 Novasina. Organic acids and sugars were obtained following the methodology previously described [3]. Antioxidant capacity and total phenols methodology of dried fruits was previously published [4] with some modifications. The methodology of descriptive sensory analysis was previously reported by Cano-Lamadrid et al. (2018) [5].

2.4. Statistics

Statistical analysis and comparison among means were carried out using the statistical package SPSS 24.0 (IBM SPSS Statist cs, Chicago, IL, USA). One–way ANOVA test was first used as type as a factor, and then used trademark as a factor. Tukey test was used for means comparison (95% confidence level).). Principal component analysis (PCA regression map) was conducted to project the samples depending on sensory attributes (XLSTAT Premium 2016, Addingsoft, Barcelona, Spain).

3. Results and Discussion

3.1. Labelling Information

Table 1 shows the ingredient list of the samples and the claims (healthy, nutritional and *"clean label"* claims). Apple and pineapple samples showed claims in 100% of the commercial brand. Added-sugar was observed in 100% of banana and cranberry samples, no-added sugar was checked in the rest of the samples.

In general, the mandatory nutritional information for each product is correct and adequate (kcal of 1 commercial brand of pinneapple are not well-calculated), being supplemented with fiber as non-mandatory information in 79.1% of the products (Table 2). A high content of fiber (labelling information) was found (>10 g/100 g) in dried coconut, apple and tomato samples. On the other hand, "no-added sugar" claim was not correct in same samples (less than 4%) because it must be accompanied by "it contains naturally present sugars" as it does not have any monosaccharides or disaccharides added, or any food used for its sweetening properties. As to vegan labelling, there is not stablished European regulation but the V-Label is an internationally recognized, registered symbol for labelling vegan and vegetarian products and services in Europe. Some trademarks do not comply with this logo (less than 20%). Regarding with organic certificate, only 1 trademark (cranberry) did not comply with this seal, using no allowed colors.

Table 2 also showed the content of sugars in 100 g of the product, being high contents of sugars (75% of samples more than 25 g/100 g), although they were no-added.

Table 2. Fiber, carbohydrates and sugar content g per 100 g of commercial dried fruits (label information).

	Fiber	**Carbohydrates**	**Sugars**		**Fiber**	**Carbohydrates**	**Sugars**
		g/100 g				**g/100 g**	
Apple 1	11	80	70	Fig 1	3	60	13
Apple 2	14.1	81	73	Fig 2	No available	57	57
Apple 3	12	83	65	Fig 3	11	78	59
Mango 1	4.4	71	46	Coconut 1	No available	15	6
Mango 2	8	73	54	Coconut 2	16.8	13.8	4.93
Mango 3	7.2	80	74	Coconut 3	14.83	8.44	6.58

Pinneaple 1	No available	68	65	Banana 1	4.5	63	14
Pinneaple 2	8	76	60	Banana 2	4	58	35
Pinneaple 3	9.4	82	62	Banana 3	3	67	18
Tomato 1	26	48	46	Cranberry 1	No available	71	65
Tomato 2	15.5	42.3	30	Cranberry 2	5.4	75	62
Tomato 3	21.2	28	28	Cranberry 3	No available	78	70.5

3.1.1. Comparison among Different Fruits

Tables 3 and 4 show the antioxidant capacity, total phenols and organic and sugar profile of all samples. Table 3 compares the values among dried fruits, and Table 4 compares the values among commercial brands within the same dried fruit. Although statistical differences were found on antioxidant capacity, total phenolic content and sugar and organic acid profile among commercial brands within dried fruit (Table 4), it can be said that dried apple and cranberry samples showed the highest total polyphenolic content, being correlated with $ABTS^{+\bullet}$ and FRAP assays (Table 3). Also, the highest content of malic and citric acid was found in tomato samples. The greater values of sucrose, glucose and fructose were identified in pineapple, cranberry and apple, respectively (Table 3). Highlights that among commercial brands in dried coco and banana no differences were found on antioxidant capacity, and among commercial brands in dried banana no differences were observed on organic acids and sugar content.

Table 3. Antioxidant capacity, total phenols and organic and sugar profile.

	DPPH	$ABTS^{+\bullet}$	FRAP	TPC	Malic	Citric	Suc	Glu	Fru
	mmol Trolox/g			mg GAE/100 g			g/100 g		
Apple	19.19 $^{b,\neq}$	12.25 ^{a}	23.0 ^{a}	668.18 ^{a}	n ^{d}	3.02 ^{b}	12.20 ^{d}	13.23 ^{d}	48.34 ^{a}
Mango	21.87 ^{a}	4.41 ^{c}	7.93 ^{d}	228.81 ^{d}	2.64 ^{c}	1.36 ^{c}	30.10 ^{b}	9.24 ^{e}	16.87 ^{d}
Pinneaple	21.61 ^{a}	3.50 $^{c\,d}$	5.68 $^{d\,e}$	254.18 ^{d}	3.02 ^{b}	1.98 ^{c}	34.79 ^{a}	18.40 ^{c}	19.62 ^{c}
Tomato	15.89 ^{c}	4.63 ^{c}	9.44 ^{c}	502.36 ^{c}	4.79 ^{a}	9.59 ^{a}	8.55 ^{e}	13.91 ^{d}	19.90 ^{c}
Fig	5.82 ^{d}	2.20 ^{d}	4.06 ^{e}	219.50 ^{d}	0.38 ^{d}	2.13 $^{b\,c}$	5.70 ^{g}	31.93 ^{b}	32.34 ^{b}
Coconut	21.71 ^{a}	1.29 ^{e}	0.70 ^{g}	51.32 ^{f}	0.35 ^{d}	0.51 ^{d}	6.86 ^{f}	6.87 ^{f}	3.18 ^{e}
Banana	20.75 ^{a,b}	2.82 ^{d}	3.25 ^{f}	151.64 ^{e}	0.56 ^{d}	N ^{d}	16.55 ^{c}	7.19 ^{e,f}	2.61 ^{e}
Cranberry	18.21 ^{b,c}	10.53 ^{b}	14.69 ^{b}	627.00 ^{b}	0.80 ^{d}	2.16 ^{b,c}	8.29 ^{e}	38.83 ^{a}	34.30 ^{b}

$^{\neq}$ Values followed by the different letter within the same column were significant different ($p < 0.05$) (ANOVA), Tukey's multiple-range test.

Table 4. Antioxidant capacity, total phenols and organic and sugar profile.

	DPPH	$ABTS^{+\bullet}$	FRAP	TPC	Citric	Malic	Suc	Glu	Fru
	mmol Trolox/g			mg GAE/100 g			g/100 g		
				Apple					
Brand 1	18.23 ^{b}	9.88 ^{b}	13.76 ^{c}	609.06 ^{b}	N ^{d}	3.60 ^{a}	10.68 ^{b}	13.80 ^{a}	45.67 ^{a}
Brand 2	18.57 ^{b}	15.89 ^{a}	34.30 ^{a}	756.05 ^{a}	N ^{d}	3.49 ^{a}	6.62 ^{c}	13.83 ^{a}	50.25 ^{a}
Brand 3	20.75 ^{a}	10.96 ^{b}	20.90 ^{b}	639.42 ^{b}	n ^{d}	1.93 ^{b}	19.30 ^{a}	12.06 ^{b}	49.10 ^{a}
				Mango					
Brand 1	20.63 ^{b}	4.16 ^{b}	9.27 ^{a}	269.35 ^{a}	1.47 ^{c}	2.36 ^{a}	26.43 ^{b}	10.01 ^{a}	20.09 ^{a}
Brand 2	21.76 ^{a,b}	2.72 ^{c}	5.11 ^{b}	125.64 ^{b}	2.77 ^{b}	0.92 ^{b}	27.67 ^{b}	9.03 ^{a}	16.64 ^{a,b}
Brand 3	23.20 ^{a}	6.34 ^{a}	9.43 ^{a}	291.43 ^{a}	3.69 ^{a}	0.81 ^{b}	36.21 ^{a}	8.67 ^{a}	13.89 ^{b}
				Pinneaple					
Brand 1	22.50 ^{a}	2.71 ^{b}	4.94 ^{b}	210.58 ^{b}	3.10 ^{a,b}	1.83 ^{b}	29.04 ^{b}	16.59 ^{a}	19.76 ^{a}
Brand 2	21.63 ^{a,b}	4.08 ^{a}	6.22 ^{a}	318.88 ^{a}	2.62 ^{b}	2.55 ^{a}	27.93 ^{b}	18.90 ^{a}	21.00 ^{a}
Brand 3	20.71 ^{b}	3.73 $^{a\,b}$	5.88 ^{a}	233.08 ^{b}	3.34 ^{a}	1.56 ^{b}	47.41 ^{a}	19.72 ^{a}	18.11 ^{a}
				Tomato					

Brand 1	14.92 [b]	6.01 [a]	12.26 [a]	558.38 [a]	6.95 [a]	6.04 [b]	9.34 [b]	15.61 [a]	24.07 [a]
Brand 2	15.23 [b]	3.78 [b]	8.63 [b]	388.51 [b]	3.17 [b]	3.07 [c]	3.48 [c]	15.65 [a]	19.43 [b]
Brand 3	17.51 [a]	4.11 [b]	7.41 [b]	560.19 [a]	4.23 [b]	19.73 [a]	12.84 [a]	10.47 [b]	16.21 [c]
				Fig					
Brand 1	4.44 [b]	3.04 [a]	3.74	278.54 [a]	0.47 [a]	2.10	5.51	30.38	29.08 [b]
Brand 2	4.07 [b]	1.85 [b]	4.21	169.22 [c]	0.33 [b]	2.20	5.78	30.68	34.68 [a]
Brand 3	8.94 [a]	1.71 [b]	4.23	210.74 [b]	0.33 [b]	2.09	5.81	34.74	33.25 [a]
				Coconut					
Brand 1	20.72	2.58	2.76	145.54 [b]	0.28 [b]	0.62 [a]	5.12 [b]	6.69	3.29 [a,b]
Brand 2	20.14	3.06	3.44	141.31 [b]	0.41 [a]	0.36 [b]	7.08 [a]	7.35	2.94 [b]
Brand 3	21.38	2.82	3.55	168.07 [a]	0.37 [a]	0.54 [a]	8.37 [a]	6.57	3.32 [a]
				Banana					
Brand 1	20.72	2.58	2.76	145.54 [b]	0.59	n [d]	16.92	6.88	2.67
Brand 2	20.14	3.06	3.44	141.31 [b]	0.50	n [d]	17.24	6.86	2.59
Brand 3	21.38	2.82	3.55	168.07 [a]	0.59	n [d]	15.50	7.83	2.58
				Cranberry					
Brand 1	19.34 [a]	10.36 [b]	11,99 [b]	633,50 [a,b]	0.78	2.23	11.12 [a]	40.27	36.05
Brand 2	19.82 [a]	8.67 [c]	12.03 [b]	571.19 [b]	0.89	2.21	6.70 [b]	36.43	32.41
Brand 3	15.48 [b]	12.57 [a]	20.04 [a]	676.30 [a]	0.74	203	7.04 [b]	39.78	34.43

[≠] Values followed by the different letter within the same column and within the type of fruit were significant different ($p < 0.05$) (ANOVA), Tukey's multiple-range test.

3.1.2. Sensory Analysis

Principal component analyses (PCAs) (Figure 1) was done to get a better understanding of the relationships among the 24 dried fruits samples, using descriptive sensory attributes (crunchiness, cohesiveness, adhesiveness, chewiness, sweetness, sourness and fruity). No off-flavors were detected. Banana, coconut and apple were positive characterized by crunchiness while the rest of the samples were correlated with cohesiveness, chewiness and adhesives. Cranberry, mango and pineapple were the most fruity, sweet and sour.

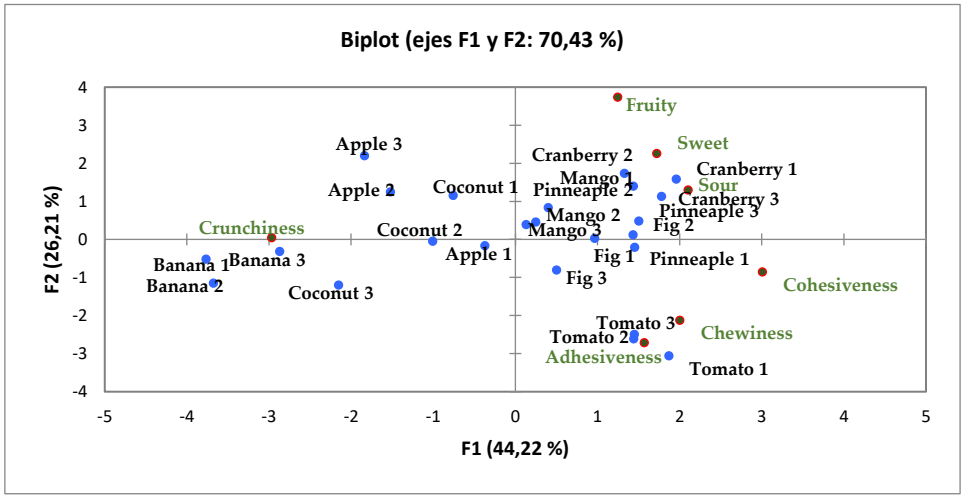

Figure 1. Principal Component Analysis of commercial dried fruit samples (PCA).

4. Conclusions

The current legislation is generally complied with, except some cases related to the vegan label, and "no added sugars" claim. There is a special trend to declare "clean label" information on dried fruits and a non-mandatory health information such as fiber content.

Commercial dried fruits are characterized by a high amount of sugars so it cannot be compared with the 400g of fresh fruit recommended by official organizations. Samples showed antioxidant capacity and total phenolic content, but the content values depend on both type of dried fruit and the commercial brand for a given dried fruit. No-off flavors were detected and texture attributes differed among types of dried fruits.

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