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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 consumer demand for healthy foods. It is essential to highlight that there is no daily recommended 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, labeling information unevenly adhered to the "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) in 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 (labeling information) was found in all the samples (75% of the samples contained more than 25 g/100 g). On the other hand, a high content of fiber (labeling 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 the 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.

Currently, 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. There is not a specific place in the supermarket dedicated to clean-label foods, and the words "*clean label*" are also not seen 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 brands of each type of dried fruit (n = 3).

2. Materials and Methods

2.1. Commercial Dried Fruits

The 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 the Alicante province (Spain). If available, each bag belonged 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.

2.2. Labeling

Compliance with current food legislation was reviewed: Regulation (UE) N° 1169/2011, Regulation (CE) N° 1924/2006, and Regulation (UE) N° 432/2012. Furthermore, 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 an Aw sprint TH-500 Novasina. Organic acids and sugars were obtained following the methodology previously described [3]. The antioxidant capacity and total phenols methodology of dried fruits were 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). A one–way ANOVA test first used as type as a factor, and then used trademark as a factor. The 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).

Table 1. Ingredient lists 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, not fried, vegan, and no-added sugar
	3	Organic sliced mango	-
Pineapple	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, not 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

3. Results and Discussion

3.1. Labeling 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 the banana and cranberry samples. No added sugar was checked in the rest of the samples.

In general, the mandatory nutritional information for each product was correct and adequate (kcal of one commercial brand of pineapple were not well calculated), being supplemented with fiber as non-mandatory information in 79.1% of the products (Table 2). A high content of fiber (labeling information) was found (>10 g/100 g) in dried coconut, apple, and tomato samples. On the other hand, the "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 labeling, there was not an established European regulation, but the V label is an internationally recognized, registered symbol for labeling vegan and vegetarian products and services in Europe. Some trademarks do not comply with this logo (less than 20%). Regarding organic certificate, only one trademark (cranberry) did not comply with this seal, using no allowed colors.

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	Not available	57	57
Apple 3	12	83	65	Fig 3	11	78	59
Mango 1	4.4	71	46	Coconut 1	Not 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
Pineapple 1	Not available	68	65	Banana 1	4.5	63	14
Pineapple 2	8	76	60	Banana 2	4	58	35
Pineapple 3	9.4	82	62	Banana 3	3	67	18
Tomato 1	26	48	46	Cranberry 1	Not available	71	65
Tomato 2	15.5	42.3	30	Cranberry 2	5.4	75	62
Tomato 3	21.2	28	28	Cranberry 3	Not available	78	70.5

Table 2 also shows that the content of sugars in 100 g of the product was high (75% of samples more than 25 g/100 g), although there were no added sugars.

3.1.1. Comparison among Different Fruits

Tables 3 and 4 show the antioxidant capacity, total phenols, and organic and sugar profiles of all samples. Table 3 compares the values among the dried fruits, and Table 4 compares the values among commercial brands within the same dried fruit. Although statistical differences were found in antioxidant capacity, total phenolic content, and sugar and organic acid profiles among the commercial brands of the dried fruits (Table 4), it can be said that the dried apple and cranberry samples showed the highest total polyphenolic content, being correlated with $ABTS^{+\bullet}$ and FRAP assays (Table 3). Furthermore, the highest content of malic and citric acid was found in tomato samples. The greatest values of sucrose, glucose, and fructose were identified in pineapple, cranberry, and apple, respectively (Table 3). This highlights that, among commercial brands of dried coco and banana, no differences were found in antioxidant capacity and, among commercial brands of dried banana, no differences were observed in organic acid 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}
Pineapple	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 a different letter within the same column were significantly different ($p < 0.05$) (ANOVA) in 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 $^{b,\neq}$	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}
					Pineapple				
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

$^{\neq}$ Values followed by a different letter within the same column and within the type of fruit were significantly different ($p < 0.05$) (ANOVA) in Tukey's multiple range test.

3.1.2. Sensory Analysis

Principal component analyses (PCAs) (Figure 1) were carried out to obtain a better understanding of the relationships among the 24 dried fruit samples, using descriptive sensory attributes (crunchiness, cohesiveness, adhesiveness, chewiness, sweetness, sourness, and fruitiness). No off flavors were detected. Banana, coconut, and apple were positively 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.

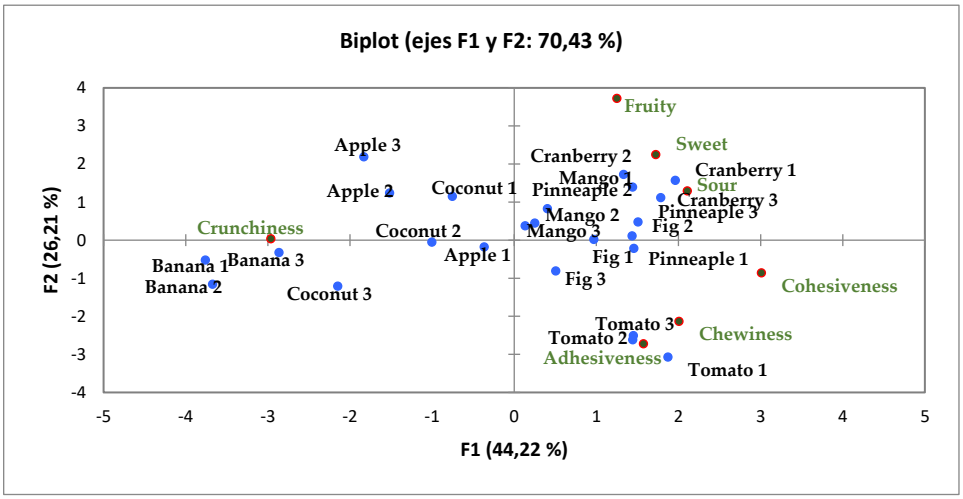

Figure 1. Principal component analysis of commercial dried fruit samples (PCA).

4. Conclusions

The current legislation is generally complied with, except in some cases related to the vegan label and the "no added sugars" claim. There is a special trend to declare "clean label" information on dried fruits and non-mandatory health information such as fiber content. Commercial dried fruits are characterized by a high amount of sugar. Therefore, they cannot be compared with the 400 g of fresh fruit recommended by official organizations. Samples showed the antioxidant capacity and total phenolic content, but the content values depend on, both, the type of dried fruit and the commercial brand of a given dried fruit. No off flavors were detected, and texture attributes differed among the types of dried fruits.

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