

Nutritional Content and Ingredients of Commercial Infant and Toddler Food Pouches Compared With Other Packages Available in the United States

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The ingredients and nutrients of infant and toddler foods (ITFs) sold in pouches were compared with products available in other packages, such as jars/packs and other containers. Company websites ($n = 21$) and in-store shelf inventory ($n = 3$) were used to create a database of commercial ITFs containing vegetables ($n = 548$) sold in the United States. Results indicated that ITFs containing

vegetables were most commonly packaged in pouches (50%), followed by “other” packages (25%) and jars/packs (25%). Infant and toddler food pouches contained significantly more sugars per serving and per Reference Amount Customarily Consumed, as well as a greater percentage of calories from sugars, compared with both jars/packs and “other” packages. Pouches were also more likely to contain vegetable/fruit blends, whereas jars/packs were more likely to contain single-vegetable or multi-vegetable blends, and “other” packages were more likely to contain vegetable/other ingredient combinations (eg, grains and/or dairy). Pouches are popular, widely available, and convenient but may not represent the vegetable profiles and nutritional qualities that parents believe they are buying for their children. *Nutr Today*. 2019;54(6):305–312

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The transition to complementary foods helps growing infants meet their nutritional needs and introduces them to the flavors and textures of foods of the family (Table 1).¹ Because early experiences with flavors and textures may provide the foundation for later food acceptance,^{2–4} it is important to expose infants to a wide variety of flavors, textures, and nutrient-dense foods during this time. National estimates suggest that between one-third and one-half of infants in the United States consume at least some commercially prepared infant and toddler foods (ITFs), with infants between 6 and 8 months old being most likely to consume at least some ITFs.^{5,6} However, there is limited evidence on whether commercially prepared ITFs provide sufficiently varied offerings to facilitate acceptance of flavors and textures associated with vegetables.

Emerging evidence suggests that infants who consume commercially prepared foods may have more nutrient-dense diets compared with nonconsumers.⁷ Specifically, ITF consumers in the 2008 US Feeding Infants and Toddlers Study ate more total vegetables and fruits (in grams) and

TABLE 1 Frequencies and Percentages of Products Available in Pouches, Jars/Packs, and “Other” Packages by Intended Infant Age/Stage

	Stage 1: 4+ mo	Stage 2: 6+ mo	Stage 3: 9+ mo	Stage 4: 12+ mo	Stage Unidentified
Jars/packs (n = 135)	21	84	29	1	0
	(53.8%)	(30.3%)	(30.2%)	(0.8%)	(0.0%)
Pouches (n = 274)	14	177	32	51	0
	(35.9%)	(63.9%)	(33.3%)	(41.1%)	(0.0%)
“Other” packages ^a (n = 139)	4	16	35	72	12
	(10.3%)	(5.8%)	(36.5%)	(58.1%)	(100.0%)
Total (% of total products)	39	277	96	124	12
	(7.1%)	(50.5%)	(17.5%)	(22.6%)	(2.2%)

^a“Other packages” include all container types besides jars/packs and pouches, including trays, packets, and canisters.

fewer sweets (eg, cookies and ice cream) compared with nonconsumers.⁷ Furthermore, infants' nutrient intakes paralleled the types of foods they consumed, with ITF consumers' diets including greater amounts of nutrients commonly found in vegetables and fruits, such as fiber, vitamin E, vitamin C, and vitamin A.⁷ However, it is noteworthy that ITF consumers' diets contained lower amounts of dark green vegetables (eg, broccoli, spinach) relative to non-ITF consumers.⁷ These data are consistent with other recent analyses, which demonstrated that dark green vegetables were less commonly included in ITFs compared with other vegetable types, such as red/orange and “other” vegetables (eg, green beans, zucchini).⁸ Collectively, this suggests that, although ITF consumers may have better overall diets on average compared with non-ITF consumers, their intake patterns are dependent, in part, on the types of foods and ingredients offered in commercially prepared ITFs.

New evidence suggests the nutrient contents of some ITFs are problematic in terms of high levels of sugars and, sometimes, sodium. According to a 2019 report from the WHO European Region, up to 1 in 4 products contain 40% or more of their calories from sugars, and approximately one-third of products contain an added sweetener, such as sugar or fruit juice concentrate.⁹ However, this report and others also suggest that there is substantial variability among products when they are classified by product type (eg, toddler meals, infant/toddler vegetables) or primary ingredients (eg, single vegetables, vegetables and fruits). For example, toddler meals and snacks in the United States commonly contain vegetables but also high levels of sodium and added sugars.^{10,11} Furthermore, products consisting of fruit and vegetable blends contain more total sugars (albeit, fruit sugars) on average than products containing only vegetables or vegetables and other

ingredients (eg, grains, dairy).⁸ It is not currently known whether high levels of sugar, and in some cases sodium, may promote greater acceptance of sweet and salty foods in later childhood and beyond.

Concurrent with the rise in fruit and vegetable blends found in ITFs, innovations in product packaging have also emerged.¹² Infant and toddler foods are now widely offered via “pouches,” and sales of these products have increased worldwide.¹³ Caregivers report that pouch products are more convenient, are easily consumed by their child while on the go, and are potentially safer than other products sold in glass jars, which may shatter when dropped.¹⁴ Little has been published about the nutritional quality of products packaged in pouches relative to more traditional packaging, such as glass jars or plastic packs. A nonsystematic Internet search of products in Germany revealed that pouch products are extremely high in total sugars.¹⁵ An examination of products available in the United States in 2015 demonstrated that pouches were more likely to contain added sugars compared with other package types.¹⁶ The present analysis compared the ingredients and nutrient contents of ITFs containing vegetables packaged in pouches versus jars/packs and “other” packages (eg, trays, packets, and canisters) in the US market. Here, we focused on ITF products containing vegetables because vegetables can be difficult to like compared with other foods¹⁷ and the variety and amount of vegetables are underconsumed by infants and toddlers in the United States.¹⁸

MATERIALS AND METHODS

Data Collection

A web-based search of companies selling ITFs was conducted between December 2016 and March 2017. Companies

were included if they were based in the United States, were currently selling ITFs containing vegetables, and had product ingredient lists and Nutrition Facts labels that could be accessed through public websites (n = 21 companies) or an in-store shelf inventory (n = 3 companies). Each product was entered into the database if the product name contained the name of a specific vegetable (eg, carrot) or the broad term “vegetable.” Juices, formulas, and drinks were excluded. In total, 548 products were included in the final database.

Relevant to the present analysis, the database included information recorded from product packaging and labels, such as intended age/stage, package type (jar/pack, pouch, or “other” package—eg, tray, packet, canister), ingredient list, serving size, and nutrition information (total calories [kcal], total carbohydrates [CHO] [g], fiber [g], and total sugars [g] per serving). Definitions for intended age/stage often vary by company, but most US companies use definitions similar to the following: stage 1, finely pureed, smooth “first” foods meant for infants approximately 4 months and older; stage 2, strained foods meant for infants approximately 6 months and older; stage 3, partially strained foods with small pieces or chunks for infants approximately 7 to 9 months and older; and stage 4, foods meant for toddlers 12 months or older. Products included in the jars/packs category included glass or plastic jars or tubs, which commonly contain pureed infant foods. Pouch products included all disposable food pouches with a spout and plastic lid. Finally, the “other” package types varied greatly and included any container not classified as a jar/pack or pouch. Examples included plastic trays commonly containing toddler dinners, packets frequently containing fruit/vegetable snacks or yogurt melts, and plastic canisters containing grain-based puffs. Using the Nutrition Facts labels for each product, sugars per 100 g and percentage of kcal from sugars were calculated. In addition, the Food and Drug Administration’s Reference Amount Customarily Consumed (RACC) per eating occasion for each product category¹⁹ was used to calculate sugars per RACC. Other product details included in the database that are not relevant to the present analysis have been published elsewhere.⁸

Ingredient lists were used to identify the presence of vegetables, fruits, and other ingredients, such as grains, dairy, and meats. Products were then categorized according to their ingredients: single-vegetable, multi-vegetable, vegetable/fruit, vegetable/meat, and vegetable/other combinations (eg, grains, dairy). Products containing only vegetables or vegetables and fruits were exclusively assigned to 1 of 3 categories: single-vegetable, multi-vegetable, or vegetable/fruit. Infant and toddler foods containing ingredients other than vegetables and/or fruits could be included in more than 1 category (eg, vegetable/meat, vegetable/other). Ingredient lists were also used to determine the

presence of vegetable and fruit juice concentrates. Juice concentrates typically added for functionality (eg, beet juice concentrate for color, lemon juice concentrate for preservation) were excluded.

Statistical Analysis

Frequencies were computed to determine the percentage of total products available in each package type and the percentage of these products intended for infants/toddlers in stages 1 through 4. A χ^2 analysis tested the association between package types and ingredient classification (single-vegetable, multi-vegetable, vegetable/fruit, vegetable/meat, and vegetable/other). Standardized residuals (SRs) were used to determine differences between observed frequencies (ie, actual frequencies) and expected frequencies (ie, calculated based on what would be expected by chance) for each cell. Residuals with an absolute value of ± 1.96 were considered significant.²⁰ That is, an SR of 1.96 or greater would indicate that the scenario was more likely than expected by chance, and an SR less than -1.96 would indicate that the scenario was less likely than expected by chance. Frequencies were also computed to determine the percentage of products containing juice concentrates available in each package type. Separate 1-way analysis of variance (ANOVA) models were used to compare each nutrient variable (total kilocalories, CHO, fiber, and total sugars per serving, per 100 g, per RACC, and percent kcal from sugars) across the 3 package types (pouch, jar/packs, and other) for all products and separately for vegetable/fruit blends; each nutrient variable was considered a separate hypothesis, so no statistical adjustment was made for family-wise error. Tukey’s Honestly Significant Difference (HSD) post hoc tests were used to test for significant differences in nutrient contents among these product package types. All statistical analyses were performed using SPSS software (version 24.0; IBM Corporation, Armonk, New York).

RESULTS

Product Availability by Package Type

Among all ITFs in the data set (n = 548), almost twice as many products were available in pouches (n = 274, 50.0%) compared with “other” packages (n = 139, 25.4%) or jars/packs (n = 135, 24.6%). Table 1 displays the percentage of pouches, jars/packs, and “other” packages intended for infants/toddlers in stages 1 through 4. Notably, stage 1 products (4+ months) were most commonly packaged in jars/packs (n = 21, 53.8%), whereas stage 2 products (6+ months) were mostly commonly packed in pouches (n = 177, 63.9%). Stage 3 products (9+ months) were evenly distributed across package types, and stage 4 products (12+ months/toddlers) were most commonly offered in “other” types of packages (eg, trays, packets, canisters).

Ingredients

Table 2 displays the percentage of pouches, jars/packs, and other packages containing vegetables plus other ingredients, as well as the number of products available in each package type by intended age/stage. A χ^2 analysis revealed a significant association between package type and product ingredients ($\chi^2_{12}(N = 548) = 186.96, P < .001$). Jars/packs were more likely than expected by chance to contain single-vegetable (SR, 7.0) or multi-vegetable (SR, 3.8) products, whereas pouches were more likely than expected to contain vegetable/fruit blends (SR, 3.5). Conversely, pouches were less likely than expected to contain single-vegetable products (SR, -2.4), and jars/packs were less likely to contain vegetable/other ingredient products (SR, -4.6). “Other” packages were more likely than expected to contain vegetable/other combinations (SR, 6.2), but they were less likely to contain single-vegetable (SR, -3.6), multi-vegetable (SR, -2.8), and vegetable/fruit (SR, -4.0) products. Vegetable/meat products were not associated with any particular package type.

Only 7% of all ITFs containing vegetables also contained vegetable or fruit juice concentrates not added for functionality (eg, color, preservation). When juice concentrates were included in products, they were most commonly added to products available in “other” packages (n = 21, 15% of “other” packages), followed by pouches (n = 17, 5% of pouches) and then jars/packs (n = 2, 1% of jars/packs).

Nutrient Content

All Products

Nutrient information (mean [SD]) by package types are displayed in Table 3. One-way ANOVAs revealed significant differences among package types for all nutrient variables examined: kcal, CHO, fiber, total sugars per serving, sugars per 100 g, sugars per RACC, and percent kcal from sugars.

Tukey HSD post hoc tests revealed that pouches contained significantly more total sugars per serving and per RACC, as well as a greater percentage of calories from sugars compared with both jars/packs and “other” packages (all P s < .001). However, products in “other” packages contained more sugars per 100 g than products available in pouches and jars/packs ($P < .001$). Products in pouches also contained more kcal per serving than products in “other” packages ($P = .007$) and more CHO per serving than both “other” packages ($P < .001$) and jars/packs ($P = .001$). In addition, pouches and jars/packs did not differ significantly on total fiber per serving, but both contained more fiber than products in “other” packages (P s < .001). Pouches and jars/packs also did not differ significantly on total kcal or sugars per 100 g.

Vegetable/Fruit Products

In the analysis of only vegetable/fruit products (n = 172), the 1-way ANOVAs remained significant for kcal, CHO, total sugars per serving, sugars per 100 g, sugars per RACC, and

percent kcal from sugars, but there were no longer significant differences among package types for fiber. Tukey HSD post hoc tests revealed that pouches and jars/packs no longer differed significantly on sugars per serving, sugars per RACC, or percentage of calories from sugars (P s > .05). However, both jars/packs and pouches contained significantly more sugars per serving, sugars per RACC, and a greater percentage of calories from sugars compared with “other” packages. Conversely, “other” packages contained significantly more sugars per 100 g compared with jars/packs and pouches. “Other” packages also contained significantly fewer kcal and carbohydrates compared with both jars/packs and pouches. These results suggest that the increased amounts of sugars in pouches is due to the higher proportion of fruit and vegetable blends sold in that type of package.

Infant and toddler foods found in pouches contained more sugars per serving and had a greater percentage of calories from sugars than ITFs found in other package types.

DISCUSSION

In the United States, between one-third and one-half of infants consume at least some commercially prepared foods,^{5,6} so it is important to investigate the nutritional quality and variety of products available for this age group. Using a snapshot of vegetable containing ITFs in the United States from 2017, we find that half were packaged in pouches. When comparing pouches with products found in jars/packs, products in pouches contain more sugars but not more fiber; however, this difference seems to be due to the greater prevalence of fruit/vegetable blends in pouches, as differences across package type disappear when looking at just fruit/vegetable blends across package type. Collectively, although pouch products are popular, widely available, and convenient,¹³ their composition (ie, vegetable only vs vegetable/fruit blends) and nutritional profiles differ from products sold in other packages.

Here, products packaged in jars/packs, pouches, and “other” packages differed in their average nutrient contents. Notably, as a category, pouches contained significantly more sugars (per serving, per RACC, and a greater percentage of calories from sugars) compared with products available in jars/packs and “other” packages. As most fruits are naturally high in sugar, increased amounts of sugars in fruit-containing products would be expected.⁸ Thus, the increased sugars in pouches (as a category) seem to be driven mainly by the higher proportion of vegetable/

TABLE 2 Frequencies and Percentages of Pouches, Jars/Packs, and “Other” Packages by Ingredients Included

	Single-Vegetable		Multi-Vegetable		Vegetable/Fruits		Vegetable/Meat ^a		Vegetable/Other ^b	
	n	% Category	n	% Category	n	% Category	n	% Category	n	% Category
Pouches	13	26.0%	16	42.1%	118	68.6%	18	37.5%	123	43.6%
Stage 1	12		0		0		0		2	
Stage 2	1		16		97		3		62	
Stage 3	0		0		6		15		23	
Stage 4	0		0		15		0		36	
Jars/packs	37	74.0%	21	55.3%	37	21.5%	15	31.3%	39	13.8%
Stage 1	21		0		0		0		0	
Stage 2	16		15		33		7		19	
Stage 3	0		5		4		8		20	
Stage 4	0		1		0		0		0	
“Other” packages ^b	0	0.0%	1	2.6%	17	9.9%	15	31.3%	120	42.5%
Stage 1	0		0		4		0		0	
Stage 2	0		1		4		1		11	
Stage 3	0		0		0		0		35	
Stage 4	0		0		9		14		62	
No stage identified	0		0		0		0		12	
Total (% of total products)	50 (9.1%)		38 (6.9%)		172 (31.3%)		48 (8.8%)		282 (51.5%)	

^aProducts containing both meat and other ingredients (eg, grains, dairy; n = 42) are counted in both the vegetable/meat and vegetable/other categories. ^b“Other” packages include all container types besides jars/packs and pouches, including trays, packets, and canisters.

TABLE 3 Nutrient Information (Mean [SD]) by Package Type

Package Type	n	kcal	CHO, g	Fiber, g	Sugars per Serving, g	Sugars per 100 g	Sugars, g/RACC ^a	% kcal From Sugars
P	548	.01	<.001	<.001	<.001	<.001	<.001	<.001
Pouches	274	67.2 (19.0) ^b	14.4 (4.3) ^b	2.0 (0.9) ^b	8.4 (4.4) ^b	7.7 (3.8) ^b	8.7 (4.3) ^b	49.9 (21.2) ^b
Jars/packs	135	63.8 (26.2) ^{b,c}	12.5 (4.7) ^c	1.9 (1.1) ^b	5.9 (3.5) ^c	5.8 (3.5) ^b	6.3 (3.6) ^c	40.8 (21.8) ^c
"Other" packages ^d	139	58.6 (39.1) ^c	9.9 (5.9) ^e	1.0 (1.3) ^c	2.6 (2.8) ^e	13.6 (16.7) ^c	3.7 (3.9) ^e	19.7 (19.4) ^e

Abbreviations: CHO = carbohydrates; HSD = Honestly Significant Difference

Means sharing the same letter (^b, ^c, and ^e) are not significantly different from other means within the same column ($P_s \geq .05$) according to an analysis of variance with Tukey HSD post hoc tests.

^aRACC = Reference Amount Customarily Consumed per eating occasion, which is used to capture typical amounts consumed of a food type when served (see Ref. 19).

^d"Other" packages include all container types besides jars/packs and pouches, including trays, packets, and canisters.

The difference in sugar content for pouches versus other package types is likely due to the higher proportion of fruit and vegetable products found in pouches.

fruit blends sold in pouches. This interpretation is supported by an analysis of just the fruit/vegetable blends ($n = 172$); when only blends are compared, differences across package type disappear. However, despite additional sugar coming from fruits, we also find that across all 548 ITFs, the pouch products did not differ from jars/packs in their fiber content. Presumably, this is because jars/packs commonly contain vegetable-only products (ie, single vegetables and multi-vegetable blends), which would provide fiber but not more sugar.

Regardless of the root cause, the high level of sugars in pouches is potentially concerning, as these products currently dominate the ITF market. It is unknown whether the sugar contents of these products influence the nutritional quality of infants' and toddlers' diets or potentially reinforce infants' innate preference for sweetness¹⁷ and influence the trajectory of the transition to family foods. It is also unknown whether the high sugar contents of these products have an impact on the dental health of infants and toddlers.¹² However, the American Academy of Pediatric Dentistry recommends avoiding the frequent consumption of foods containing sugars to decrease the risk of early childhood dental caries.²¹ Although fruits certainly contain other beneficial nutrients (eg, vitamin C or various phytonutrients), ITFs containing fruit purées and juice concentrates may have a "health halos" that lead caregivers to believe such blends

are more healthful than they truly are, especially when high in sugars but low in fiber. More work is needed to determine how caregivers view these products.

Although jars/packs also frequently contain vegetable/fruit blends, they were the only package type to contain a considerable number of single-ingredient products. This is a key finding, as both the American Academy of Pediatrics and the Supplemental Nutrition Program for Women, Infants and Children recommend introducing infants to single foods to monitor both food allergies and acceptance of flavors.^{22,23} Recently, we reported that single-ingredient products comprise less than 10% of the total number of commercial ITFs containing vegetables and the vast majority of these products are intended for infants in stage 1.⁸ Here, we extend this finding to show that these single-ingredient products are mostly available in jars/packs, are far less commonly found in pouches, and are almost never found in other types of containers. Caregivers who wish to introduce single foods and flavors to their infants/toddlers currently have very limited options from commercial products. This suggests caregivers may need to supplement commercial offerings by preparing single-ingredient vegetables at home to adequately expose their child to the full range of vegetables and flavors.

In addition to differences in nutrient contents and typical ingredients, there were also differences in the package types intended for infants/toddlers in different developmental stages. For example, more than half of stage 1 products were available in jars/packs, two-thirds of stage 2 products were available in pouches, and more than half of stage 4 products were available in "other" packages. Critically, the intended age/stage of the product has implications for the product's ingredients and, therefore, nutrients. Stage 1 products almost exclusively contained single vegetables, stage 2 products commonly included combinations of vegetables and fruits, and stage 4 products contained

Products consisting of a single vegetable are uncommon. Thus, caregivers may choose to supplement commercial ITFs with single vegetables prepared at home to ensure exposure to a broad range of flavors.

all foods intended for toddlers such as toddler dinners and fruit or grain-based snacks. Thus, the intended age/stage of the product frequently confounded associations between package type and ingredients/nutrients and needs to be considered when interpreting such associations.

Because different package types seem to be targeted toward infants/toddlers in different stages, it is important to understand how the package type and its contents contribute to infant/toddler development during that stage. For example, stage 1 products available in jars/packs need to be spoon-fed by the caregiver to the child because young infants are not capable of feeding themselves with a spoon at this early stage. In addition, the greatest number of pouch products was classified as stage 2, suggesting they are likely strained foods intended for infants 6 months and older. However, the period between 6 and 9 months is one of rapid physical and oral-motor development when infants learn to chew vertically and lateralize food in their mouths. During this time, infants can also start processing thick, lumpy purées and self-feeding finger foods.² It is currently unknown whether the contents of ITF pouches support infants' oral-motor development and their new skills in this area. Furthermore, later infancy and toddlerhood are also characterized by increased reciprocity between infants and their caregivers, especially when caregivers practice responsive feeding.² When infants begin to self-feed the contents of pouches, it is unknown whether caregivers continue to practice responsive feeding techniques. To better understand how pouches and other packages may affect child health and development, research is needed on when (eg, child age) and how (eg, child vs caregiver in control, presence/absence of caregivers) these products are fed to infants/toddlers. Collectively, this work can contribute to the questions being asked by the 2020 Dietary Guidelines for Americans Committee's Birth to 24 Months Subcommittee related to complementary feeding and micronutrients, growth, size, and body composition.²⁴

The present analysis was based on a systematic investigation of all ITFs containing vegetables available in jars/packs, pouches, and "other" packages nominally offered for sale in the United States in early 2017. These data,

culled from manufacturers' websites, are believed to form a comprehensive list of 500+ products; however, this list may not be exhaustive, as it remains possible that some relevant products and companies were not included here because of the lack of an online presence. In addition, because the data came from manufacturers' websites, it is possible that some products are in very limited production and/or distribution. At the outset, we intentionally focused only on products containing vegetables, as these foods can be difficult to like¹⁷ and are underconsumed by infants and toddlers in the United States¹⁸; however, this also means our results should not be generalized to other ITF products without vegetables. Furthermore, we limited our nutrient analysis to kilocalories, sugars, and dietary fiber, so it is possible that various package types may also differ on specific micronutrients, some of which are not reported on Nutrition Facts labels. For example, 1 recent analysis demonstrated that pouch products were significantly higher in vitamin C compared with products in other packages.¹⁶ It is also important to note that the results reported here are based on averages across package types. Because substantial variability occurs within a package type, individual products may not resemble other typical products in the same type of package. Finally, we caution that these data represent product offerings obtained from company websites at a specific point in time and not sales data or reported or observed consumption of these products by infants and toddlers.

CONCLUSIONS

The present analysis extends emerging evidence on differences in nutritional quality among certain subgroups of commercial ITFs available in the United States. Pouch products contain higher levels of sugars and potentially less vegetable content than similar products available in jars/packs. To date, only anecdotal evidence exists for why caregivers select pouch products for their infants/toddlers, and it is unknown whether caregivers are aware of the sugar contents and ingredients of these products. Thus, all caregivers should be encouraged to examine Nutrition Facts labels and ingredient lists closely to select products low in sugars with the ingredients they wish to offer to their children.

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