

# Canned Fruits, Vegetables, Beans and Fish Provide Nutrients at a Lower Cost Compared to Fresh, Frozen or Dried

Cathy Kapica\* and Wendy Weiss

Global Health and Wellness, Ketchum Inc, Chicago, IL, USA

## Introduction

Around the world, there is a call to increase the consumption of fruits and vegetables [1], which are rich sources of essential nutrients, such as vitamins C and A, as well as fiber and phytonutrients [2]. Diets high in fruits and vegetables reduce the risk of several chronic diseases, including obesity, diabetes and heart disease [1]. In the United States, the call for increased fruit and vegetable consumption often emphasizes fresh [3]. There is a growing misperception that processing of foods diminishes nutritional quality [4]. However, fruits, vegetables and other foods that are to be frozen, canned or dried are usually picked at their prime and processed close to harvest time and location, and deliver consistent quality, flavor and safety, as well as nutrition and convenience [4].

The potential reduced nutritional quality of preparations other than fresh is often cited as the rationale for the focus on fresh [5], despite research that shows the nutritional equivalent or, in some cases, superiority of frozen or canned foods to cooked or raw fresh foods [6,7]. Previous research has shown that dietary fiber, vitamin A, carotenoids, folate and protein are maintained during thermal processes, such as used during canning [8]. Canning reduces the risk of food borne illness [9], and is the most recycled food container [10]. Canning results in an affordable source of recommended foods [11].

With economic concerns at the forefront, households are challenged to meet dietary recommendations within budgetary constraints. Foods, especially fruits and vegetables, which are frozen, canned or dried, have a longer shelf life than fresh, with little waste, which helps household food preparers save money and not worry about spoilage. To help families develop the confidence needed to make decisions regarding food form and their concomitant costs to purchase, and time cost to prepare and serve, it is important to investigate the relationships among nutrient content, economic and time costs, and skills needed. Thus, the purpose of this study was to compare the nutritional content to the economic and time cost for the average household manager to serve edible portions of various fruits, vegetables and protein foods in their fresh, frozen, canned and dried forms.

## Methods

This market-basket cost analysis study involved the purchase and preparation of specific foods; the timing and recording of that preparation; gathering nutritional data; and comparisons among all food items to assess any differences. These methods did not require institutional review board approval since no subjects were involved.

## Food collection

Food samples were purchased at grocery, produce or specialty stores in northern New Jersey between August and October 2011. The foods selected for measurement represented those that are commonly available in fresh, frozen, canned and dried forms, and included corn, green snap beans, mushrooms, peas, pumpkin, spinach, tomatoes, pears, peaches, pinto beans and tuna fish. Not all foods were available

in all forms. All items were selected in the store in a manner consistent with the approach of an average homemaker: frozen, canned and dried items were pulled randomly from retail shelf or freezer, and the freshest appearing items were selected from produce bins. These foods were purchased in a quantity sufficient to prepare a 1-cup serving. Canned mushrooms are most commonly button mushrooms; dried mushrooms are least commonly button mushrooms, so a blend of mushroom varieties was selected as the next most reasonably priced dried option. Mushrooms canned in jars were also included. All varieties purchased were with no added salt or sugar (when available). Selling prices for several brand-name and store brand items for each food category were recorded during the same shopping week to obtain an average price. All prices were recorded in a Microsoft Excel spreadsheet

## Food preparation

Time spent shopping for food items was not recorded. Time spent preparing and cooking was recorded for each food. All food was prepared by one Registered Dietitian, in a manner consistent with the everyday skills of a homemaker and mother. Foods were prepared to a consistent texture across all forms. All preparation took place in a home kitchen at sea-level altitude. All foods were cooked in a stainless steel pot, on a gas range top, according to package directions (where available), and without added ingredients, to obtain comparable edible portion sizes. For those foods without cooking instructions, preparation was as follows: Fresh tomatoes were cooked without water in a saucepan on medium-high heat, boiled until soft (measured by similarity to the canned form), drained and pureed with a hand-held blender until smooth. Dried beans were rinsed and soaked in a pot covered by room temperature tap water for two hours, boiled in fresh tap water on high heat until the same consistency as canned beans, then rinsed and drained in a colander. Dried peaches, pears and peas were rehydrated by soaking in room temperature tap water until food was plump with moisture, boiled until a similar consistency as the canned preparation, and drained in a colander to remove residual cooking water. Fresh corn and pumpkin were boiled in a large saucepan on high heat until tender, and drained. The kernels were sliced off the cooked corn cob. Pumpkin was pureed using a hand-held mixer. Fresh mushrooms (sliced), green beans (rinsed, ends trimmed), baby spinach (rinsed) and were boiled in tap water on high heat until a similar consistency as canned, then drained to remove all residual water. Fresh and frozen fish was baked

\*Corresponding author: Dr. Cathy Kapica, Global Health and Wellness, Ketchum Inc, Chicago, IL, USA, E-mail: [cathy.kapica@ketchum.com](mailto:cathy.kapica@ketchum.com)

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to medium doneness (until opaque throughout). Time spent preparing and cooking each food was tracked by a single preparer using a kitchen timer. The timer was started prior to all rinsing, opening, preparing (including all peeling, slicing, chopping, pureeing, etc.) and heating, and stopped when food was cooked to the desired, finished form. Total time and measured weights for a single analysis were recorded in a Microsoft Excel spreadsheet by the food preparer.

Measurements were taken for edible portions based on servings recommended in the United States Department of Agriculture's (USDA) MyPlate food guidance system [12]. Cooked portions were measured for quantity and weight using home kitchen measuring cups and a food scale (OXO #1130800, re-calibrated with each use) as follows: one cup of vegetables (counts toward one cup of vegetables); one cup of fruit (counts toward one cup of fruit); one ounce of fish (counts toward one ounce equivalent of protein food); one cup of beans (counts toward one cup of vegetables or two ounce equivalents of protein food). Food waste (defined as non-edible portion only, including all rind, stem and tough or inedible exterior) was gathered during preparation, weighed, and recorded in a Microsoft Excel spreadsheet by the food preparer.

### Data calculation

Nutrients selected for comparison included "nutrients of concern" for children, adolescents and adults [2] as well as those commonly found in these food items and included protein, fiber, potassium, vitamin C, vitamin A and folate. Nutrient content of all food items was determined from the USDA Nutrient Data Laboratory, Standard Release 24 [13]. Price calculations were based on the average price of each food item in each form. Total cost per edible portion (TCEP) was calculated by adding the average price per drained, prepared, edible serving to the cost of any waste (waste weight measure, mostly found with fresh preparation, was multiplied by selling cost per pound) and to the value on time spent during preparation. Cost per nutrient (CN) was calculated by dividing total cost per edible portion by the amount of each nutrient available in that portion. The value of time spent on preparation was calculated based on the minimum wage in New Jersey at the time of the study (\$7.25 per hour) [14].

### Results

Table 1 summarizes the results. In general, canned foods had the lowest TCEP and lower or comparable CN when compared to other forms. Dried beans were about 685% more costly for protein, fiber, potassium and folate than canned beans when the selling price and time cost of preparation were taken into consideration.

Of the other vegetables, only mushrooms and peas were available in the dried form. Frozen tomatoes were not available, and dried tomatoes were only available packed in oil, so were not included in the analysis. Fresh tomatoes had nearly 60% higher cost per gram of fiber than canned tomatoes, primarily due to a 20% higher base cost per edible portion and 30% greater preparation time. While fresh corn had a lower base cost per edible portion compared to canned or frozen, the cost per gram of fiber was 25% more and for folate 75% more, primarily due to its longer preparation time and the amount of waste. Fresh pumpkin had a nearly 950% greater CN for fiber, potassium, vitamin C, folate, and vitamin A than canned pumpkin, primarily due to its greater base cost per edible portion (210% higher) and its longer preparation time (about 975% higher). To rinse, slice and boil fresh mushrooms took more than 200% longer than to warm canned mushrooms, which had the lowest CN for fiber. With equivalent preparation time between canned and fresh spinach, canned had an 85% lower CN for fiber and

vitamin C, mostly related to its 53% higher base cost per edible portion.

The CN for protein from fresh tuna was 1800% higher than canned tuna, primarily due to its longer preparation time (430% higher) and greater base cost per edible portion (175% higher). The CN for frozen tuna was 2500% higher due to defrosting and cooking time (833% longer preparation time) compared to canned.

### Discussion

This market-basket time and price cost assessment compared edible portions of select foods' cost-per-nutrients in fresh, canned, frozen and dried preparations and found canned to offer better value most often. While the category prices were based on averages of the canned foods which had different individual prices, this nutritional value was evident even when the highest priced canned food brand was used in the comparison (data not shown). While many of these differences were small, for a household manager on a tight budget, every cost savings can help to serve adequate nutrition to the family. The finding that canned foods were lower in price compared to fresh or frozen is consistent with the findings of the USDA's Quarterly Food-at-Home Price Database [15].

Too often when dietary guidance is given, factors beyond nutrition, such as practical time commitment and skills required to serve a nutritious meal, are not taken into consideration. The USDA Thrifty Food Plan only takes into consideration the price of food [16] as does the USDA Economic Research Service assessment of the cost of fruit and vegetables [17]. Programs to promote produce consumption, particularly among low-income populations, emphasize fresh, yet have not seen fruit and vegetable consumption increase to amounts needed to meet dietary guidance [18,19]. Availability of in-home storage and cooking facilities, physical skills, availability and literacy to read and follow recipes and preparation needs, as well as shorter shelf life and variable quality, are all factors that may be presenting barriers to the use of fresh foods [20]. When preparation time is included, if a female between the ages of 14 and 50 years were to meet the 2½ cup daily vegetable recommendation using only spinach, the TCEP would be \$2.85 for canned compared to \$5.52 for fresh spinach. Yet, the amount of fiber, potassium, folate and vitamin A are similar. It only costs \$0.01 for a gram folate in a serving of canned spinach, which provides 42% of daily folate requirements. Obtaining nutrients from canned foods that meet consumer needs for taste, convenience, affordability, preparation skill and storability will help meet dietary guidelines, especially for nutrients such as potassium, which tend to be more costly to add to the diet [21].

One of the criticisms of prepared foods, such as those that are canned, is the addition of less desirable ingredients such as salt and sugar. Canned and frozen foods without added salt or sugar (as were used in this study) are becoming increasingly available, and preference for these should be encouraged. When not available, draining and rinsing can reduce sodium and sugar content. Draining canned beans has been shown to reduce sodium 36%; draining and rinsing reduces sodium by 41% [22].

There were several limitations in this study which may affect the interpretation of the outcomes. Multiple data-collectors were not used. Stove-top preparation was chosen as the standard method for heating/cooking the foods. Microwave cooking may have shortened the cooking times. Nutrient content of the foods was not analyzed, but determined from the USDA Nutrient Data Laboratory database. This led to the discovery of some apparent anomalies in these data often

Food	Price per edible portion*	Time to prepare (minutes)	Waste (grams)	Total cost per edible portion* (TCEP)	Cost per gram of protein*	Cost per gram of fiber*	Cost per mg of potassium*	Cost per mg vitamin C	Cost per mcg of folate*	Cost per IU vitamin A
<b>Pinto beans</b>										
canned	0.36	6.00	0	1.08	0.09	0.12	0.00	--	0.03	--
dried	0.47	145.50	0	18.05	1.29	1.29	0.03	--	0.07	--
<b>Green beans</b>										
canned	0.27	8.0	0	1.24	--	0.41	0.01	0.35	0.03	--
fresh	0.36	8.5	65	1.96	--	0.49	0.01	0.16	0.05	--
frozen	0.78	18.0	0	2.95	--	0.74	0.01	0.49	0.09	--
<b>Corn</b>										
canned	0.41	7.5	0	1.32	--	0.44	0.01	0.44	0.02	0.02
fresh	0.16	13.5	422	2.45	--	0.61	0.01	0.27	0.06	0.01
frozen	0.79	9.5	0	1.93	--	0.48	0.01	0.32	0.03	0.01
<b>Mushrooms</b>										
canned	1.48	7.0	0	2.32	--	0.58	0.01	3.00	0.12	--
fresh	1.09	22.0	0	3.75	--	0.94	0.01	0.63	0.13	--
jarred	2.16	7.0	0	3.01	--	0.75	--	0.00	--	--
dried	32.95	27.0	0	36.21	--	2.01	0.02	6.03	0.14	--
<b>Peas</b>										
canned	0.38	7.5	0	1.28	--	0.18	0.00	0.09	0.02	--
fresh	1.57	9.5	0	2.72	--	0.68	0.01	0.04	0.06	--
frozen	0.85	8.3	0	1.86	--	0.21	0.01	0.12	0.02	--
dried	9.58	75.0	0	18.65	--	1.10	--	0.28	--	--
<b>Pumpkin</b>										
canned	0.79	6.0	0	1.52	--	0.19	0.00	0.14	0.05	0.00
fresh	2.46	23.0	1012	16.31	--	6.52	0.03	1.48	0.82	0.00
<b>Spinach</b>										
canned	0.49	8.0	0	1.45	--	0.36	0.00	0.06	0.01	0.00
fresh	0.75	8.0	120	2.21	--	0.55	0.00	0.13	0.01	0.00
frozen	1.20	8.0	0	2.16	--	0.36	0.00	0.54	0.01	0.00
<b>Tomatoes</b>										
canned	0.43	8.0	0	1.40	--	0.71	0.00	0.07	0.05	0.00
fresh	0.51	10.5	2	1.79	--	1.19	0.00	0.04	0.06	0.00
<b>Peaches</b>										
canned	0.54	0.5	0	0.60	--	0.72	0.00	0.14	0.05	0.00
fresh	0.93	13.5	95	2.97	--	0.99	0.01	0.21	0.37	0.00
frozen	1.64	18.0	0	3.82	--	0.95	0.01	0.02	0.64	0.01
dried	8.06	45.0	0	13.50	--	--	0.02	1.69	4.50	0.03
<b>Pears</b>										
canned	0.74	0.5	0	0.80	--	0.27	0.01	0.40	0.13	--
fresh	0.62	14.0	122	2.67	--	0.38	0.01	0.30	0.18	0.05
<b>Tuna</b>										
canned	0.26	1.5	0	0.44	0.01	--	--	--	0.15	0.02
fresh	0.72	8.0	0	1.68	0.19	--	--	--	1.68	0.08
frozen	0.37	14.0	0	2.07	0.26	--	--	--	2.07	0.11

**Table 1:** Nutrient per cost comparison of beans, vegetables, fruit and tuna fish (in US dollars)

\*Total cost per edible portion (TCEP) = average price per edible portion + cost of waste + cost value of preparation time. Cost per nutrient = total cost per edible portion/ amount of nutrient available in that portion. Anything less than one cent is listed as zero.

-- indicates that this nutrient is found in either negligible amounts or there was no data available.

used as a gold-standard nutritional reference. For example, canned pumpkin pie mix (containing pure pumpkin, sugar, water and spices) was listed as containing 22 grams of fiber per serving, whereas canned pure pumpkin is listed with 10 grams for the same amount. In addition, an assumption was made that each food item in a category would be used in the same way; for example, that canned, frozen, and fresh spinach would be boiled and drained. Consumers may use various prepared forms of food in different ways. Not all foods selected were available in comparable variety across the food preparations. The price of mushroom varieties alone could contribute to the differences seen

with mushrooms. It was assumed that during preparation time, such as soaking and cooking dried beans, that the food preparer's time would be limited to that task. While in reality this is unlikely, the home manager would need to plan in advance to begin the food preparation, so including this in the time cost is reasonable when the goal is to determine how long it takes to make the meal ready-to-eat.

It is important to include a variety of foods into a well-balanced eating style. Canned foods are an economical and time-saving source of key nutrients. In making dietary recommendations, especially for fruits and vegetables, specifically including canned varieties and not

only fresh could make needed nutrients more accessible to consumers, particularly for those who live in “food deserts” and those with limited storage, preparation facilities, limited time, skill or interest in preparing foods.

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