

Giovanni Martinez

MSDS 460

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Introduction

The U.S. Food and Drug Administration has established a set of recommended dietary allowances encompassing various nutrients and calorie guidelines. This paper aims to formulate an optimized weekly meal plan comprising five distinct meals. The primary objective is to minimize costs while ensuring that the nutritional requirements outlined by the FDA are met effectively.

Methods

The initial phase involves compiling a list of my typical weekly food items. To streamline this process, I opted for five easily preparable meals, each consisting of minimal ingredients. The chosen meals include rice with chicken and vegetables, ground beef with pasta, cereal with milk, a protein meal bar, and eggs with pancakes.

Subsequently, I proceeded to gather comprehensive nutritional data for the ingredients in each meal. This involved researching each item on the Walmart website, noting its price, and recording the published nutritional information. The values were converted into percentages based on the seven components and daily recommended intake.

Component	Max/Min	Daily Amount and measure	Cerial	Chicken	Eggs	Beef	Milk	Veggies	Pancakes	Pasta	Protein Bar	Rice
Sodium	Maximum	5000 milligrams (mg)	2.7 %	.8 %	1.4 %	1.5 %	3.2 %	.3 %	9.8 %	0 %	11 %	0 %
Energy	Minimum	2000 Calories (kilocalories, kcal)	6.5 %	7 %	3.5 %	8.5 %	6.5 %	1.75 %	8 %	10 %	12 %	8 %
Protein	Minimum	50 grams (g)	4 %	50 %	12 %	46 %	16 %	4 %	10 %	14 %	32 %	6 %
Vitamin D	Minimum	20 micrograms (mcg)	10 %	0 %	5 %	0 %	10 %	2 %	0 %	0 %	0 %	0 %
Calcium	Minimum	1,300 milligrams (mg)	0 %	0 %	0 %	0 %	25 %	0 %	4.6 %	0 %	4.6 %	0 %
Iron	Minimum	18 milligrams (mg)	60 %	0 %	5 %	15 %	0 %	3.9 %	8.8 %	11 %	8.8 %	5.6 %
Potassium	Minimum	4700 milligrams (mg)	1.38 %	0 %	0 %	0 %	8 %	4.6 %	1 %	2.5 %	4.6 %	1.1 %
Cost per serving	n/a	dollars (\$)	.25	.89	.22	1.49	.17	.36	.16	.22	1.8	.1

The cost per serving was calculated by dividing the item's cost by the number of servings in the package. After aggregating the nutritional information, a table detailing the meals and their respective values was constructed.

Component	Meal a	Meal b	Meal c	Meal d	Meal e
Sodium	1.1	1.5	5.9	11.0	11.2
Energy	16.75	18.5	13.0	12.0	11.5
Protein	60.0	60.0	20.0	32.0	22.0
Vitamin D	2.0	0.0	20.0	0.0	5.0
Calcium	0.0	0.0	25.0	4.6	4.6
Iron	9.5	26.0	60.0	8.8	13.8
Potassium	5.7	2.5	9.38	4.6	1.0
Cost per serving	1.35	1.71	0.42	1.8	0.38

Functions

The variables in this problem are the servings of the five different meals.

```
# define variables
meal_a = LpVariable("Meal a", 0, None) # Meal a >= 0
meal_b = LpVariable("Meal b", 0, None) # Meal b >= 0
meal_c = LpVariable("Meal c", 0, None) # Meal c >= 0
meal_d = LpVariable("Meal d", 0, None) # Meal d >= 0
meal_e = LpVariable("Meal e", 0, None) # Meal e >= 0
```

The problem underwent seven iterations to compute the nutritional requirements for each of the seven days.

```
for i in range(1,8): #iterate through number of days
```

The initial constraints were related to daily nutritional requirements, which had already been converted into percentages. Consequently, the equations were normalized to 100 on the right-hand side.

```
prob += 1.1 * meal_a + 1.5 * meal_b + 5.9 * meal_c + 11.0 * meal_d + 11.2 * meal_e <= 100 # sodium
prob += 16.75 * meal_a + 18.5 * meal_b + 13.0 * meal_c + 12.0 * meal_d + 11.5 * meal_e >= 100 # Energy
prob += 60.0 * meal_a + 60.0 * meal_b + 20.0 * meal_c + 32.0 * meal_d + 22.0 * meal_e >= 100 # Protein
prob += 2.0 * meal_a + 0 * meal_b + 20 * meal_c + 0 * meal_d + 5 * meal_e >= 100 # Vitamin D
prob += 0 * meal_a + 0 * meal_b + 25 * meal_c + 4.6 * meal_d + 4.6 * meal_e >= 100 # Calcium
prob += 9.5 * meal_a + 26.0 * meal_b + 60.0 * meal_c + 8.8 * meal_d + 13.8 * meal_e >= 100 # Iron
prob += 5.7 * meal_a + 2.5 * meal_b + 9.38 * meal_c + 4.6 * meal_d + 1.0 * meal_e >= 100 # Potassium
```

One of the requirements was that each meal must be incorporated at least once during the week, to fulfill this requirement, an if statement was devised. This statement established a condition wherein each meal was set to a minimum of one occurrence per iteration until all five meals were included. Once this condition was met for each meal, it became inactive, ensuring that the requirement was satisfied for the entire week.

```
Meal_list = [meal_a,meal_b,meal_c,meal_d,meal_e]

if i <= len(Meal_list):
    prob += Meal_list[i-1] >= 1 # Minimum item
```

In the context of this minimization problem, the objective function is defined as the total cost sum of the meals.

```
# define objective function
prob += 1.35 * meal_a + 1.71 * meal_b + 0.42 * meal_c + 1.8 * meal_d + 0.38 * meal_e
```

Results

Upon running the code without enforcing the condition that each meal must be included at least once, the optimized solution revealed 7.7 portion servings for Meal C, consisting of cereal and milk. The cost of this meal is 3.23 per day or 22.61 per week.

```
status=Optimal
Meal_a = 0.0
Meal_b = 0.0
Meal_c = 7.6923077
Meal_d = 0.0
Meal_e = 0.0
Day 3 Cost = $3.230769234
```

Once the minimum. conditions were introduced, four of the days yielded the following results.

```
status=Optimal
Meal_a = 1.0
Meal_b = 0.0
Meal_c = 6.7453505
Meal_d = 0.0
Meal_e = 0.0
Day 1 Cost = $4.18304721
```

```
status=Optimal
Meal_a = 0.0
Meal_b = 1.0
Meal_c = 6.9742489
Meal_d = 0.0
Meal_e = 0.0
Day 2 Cost = $4.639184538
```

```
status=Optimal
Meal_a = 0.0
Meal_b = 0.0
Meal_c = 7.1530758
Meal_d = 1.0
Meal_e = 0.0
Day 4 Cost = $4.804291836
```

```
status=Optimal
Meal_a = 0.0
Meal_b = 0.0
Meal_c = 7.1530758
Meal_d = 1.0
Meal_e = 0.0
Day 4 Cost = $4.804291836
```

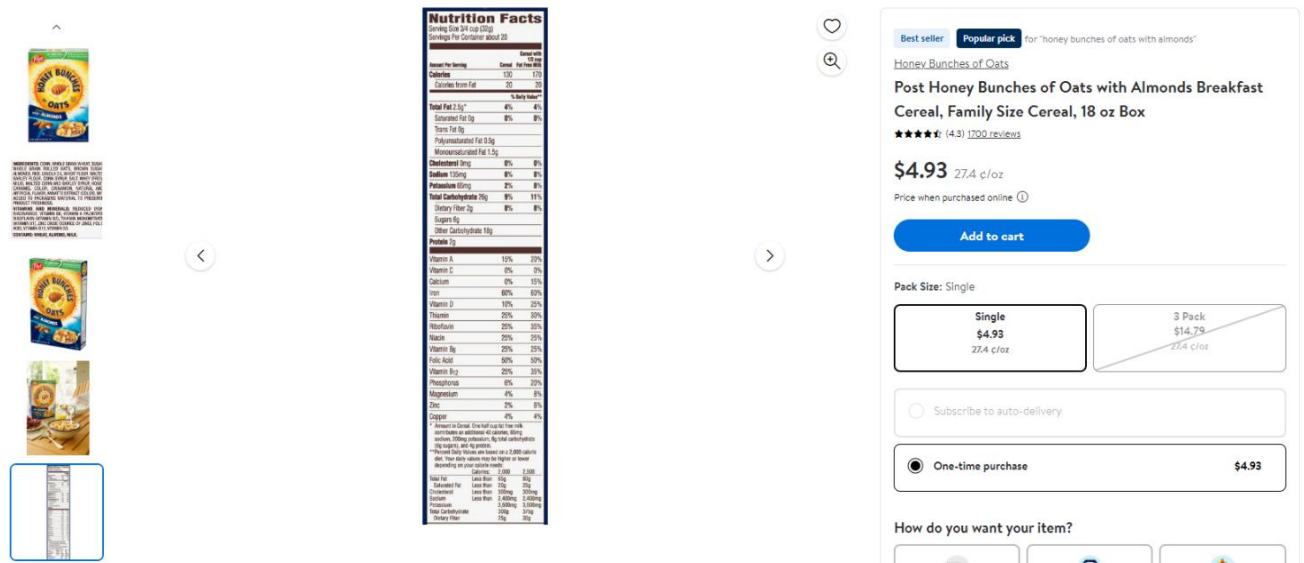
The remaining three days only included meal C, the total weekly cost was found to be \$26.66

Conclusion

Meal C, comprising cereal and milk, emerged as the most cost-effective option. This outcome may be attributed to the fact that artificially enriched cereal provides a significant quantity of essential nutrients, while the addition of milk contributes essential protein and calcium.

To better represent typical daily meal intake, the problem necessitates additional conditions. This is essential because cereal is not typically consumed as the sole food throughout the week. Proposed conditions include setting limits on maximum servings and maximum meals per meal type (e.g., breakfast-like food or lunch/dinner).

Appendix



Nutrition Facts
Serving Size 3/4 cup (52g)
Servings Per Container about 20

Amount Per Serving		% Daily Value*
Calories	120	10%
Total Fat 1 1/2g	4%	4%
Saturated Fat 0g	0%	0%
Trans Fat 0g	0%	0%
Polyunsaturated Fat 0.5g	1%	1%
Monounsaturated Fat 0.5g	1%	1%
Cholesterol 0mg	0%	0%
Sodium 150mg	3%	3%
Total Carbohydrate 25g	8%	16%
Dietary Fiber 2g	8%	8%
Sugars 1g	2%	2%
Other Carbohydrate 15g		
Protein 3g		
Vitamin A	10%	20%
Vitamin C	0%	0%
Calcium	0%	0%
Iron	60%	60%
Vitamin D	10%	20%
Thiamin	20%	20%
Riboflavin	20%	20%
Niacin	20%	20%
Vitamin B6	20%	20%
Folate	10%	10%
Vitamin B12	20%	20%
Phosphorus	0%	0%
Magnesium	0%	0%
Zinc	2%	2%
Copper	0%	0%

*Percent Daily Values are based on a diet of other people's secrets.

Post Honey Bunches of Oats with Almonds Breakfast Cereal, Family Size Cereal, 18 oz Box
★★★★★ (4.3) 1700 reviews
\$4.93 27.4 ¢/oz
Price when purchased online ⓘ
Add to cart

Pack Size: Single

Single \$4.93 27.4 ¢/oz	3 Pack \$14.79 27.4 ¢/oz
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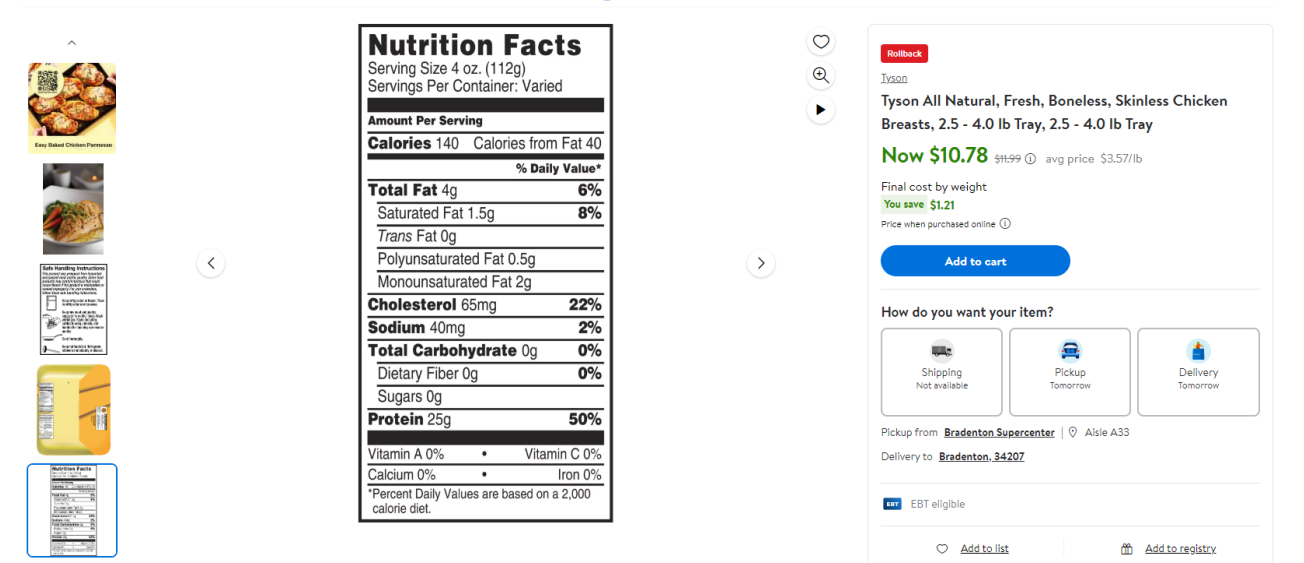
☐ Subscribe to auto-delivery

☒ One-time purchase **\$4.93**

How do you want your item?

☐ Shipping Not available ☒ Pickup Tomorrow ☐ Delivery Tomorrow

Figure 1



Nutrition Facts
Serving Size 4 oz. (112g)
Servings Per Container: Varied

Amount Per Serving		% Daily Value*
Calories 140	Calories from Fat 40	
Total Fat 4g	6%	
Saturated Fat 1.5g	8%	
Trans Fat 0g		
Polyunsaturated Fat 0.5g		
Monounsaturated Fat 2g		
Cholesterol 65mg	22%	
Sodium 40mg	2%	
Total Carbohydrate 0g	0%	
Dietary Fiber 0g	0%	
Sugars 0g		
Protein 25g	50%	
Vitamin A 0%		Vitamin C 0%
Calcium 0%		Iron 0%

*Percent Daily Values are based on a 2,000 calorie diet.

Tyson
Tyson All Natural, Fresh, Boneless, Skinless Chicken Breasts, 2.5 - 4.0 lb Tray, 2.5 - 4.0 lb Tray
Now \$10.78 \$11.99 ⓘ avg price \$3.57/lb
Final cost by weight
You save \$1.21
Price when purchased online ⓘ
Add to cart

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Pickup from **Bradenton Supercenter** | Aisle A33
Delivery to **Bradenton, 34207**

☒ EBT eligible

☐ Add to list ☐ Add to registry

Figure 2



Nutrition Facts			
Amount/serving		% Daily Value*	
Total Fat 5g		6%	
Saturated Fat 1.5g		8%	
Trans Fat 0g		0%	
Cholesterol 185mg		62%	
Sodium 70mg		3%	
Protein 0g		12%	
Vitamin D 1mcg 0% • Calcium 30mg 2% • Iron 0.9mg 4% • Potassium 70mg 0%			

*The % Daily Value is based on a diet of 2000 calories a day. It is not intended to be used for general nutritional advice.



Best seller

Marketside

Marketside Large Cage-Free Brown Eggs, 12 Count

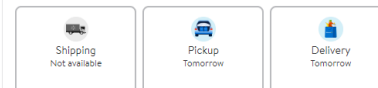
★★★★☆ (2.5) 52% reviews

\$2.66 22.2 c/ea

Price when purchased online ⓘ

Add to cart

How do you want your item?



Pickup from Bradenton Supercenter | Aisle A31

Delivery to Bradenton, 34207

CDT with Prime

Figure 3



Nutrition Facts	
Serving Size 4 OZ. (112g)	
Servings Per Container VARIED	
Amount Per Serving	
Calories 170	Calories from Fat 70
% Daily Value*	
Total Fat 8g	12%
Saturated Fat 3.5g	18%
Cholesterol 70mg	23%
Sodium 75mg	3%
Total Carbohydrate 0g	0%
Protein 23g	
Iron 15%	
Not a significant source of dietary fiber, sugars, vitamin A, vitamin C and calcium.	
*Percent Daily Values are based on a 2,000 calorie diet.	



Best seller

Fresh Ground Beef

All Natural* 93% Lean/7% Fat Lean Ground Beef, 1 lb Roll

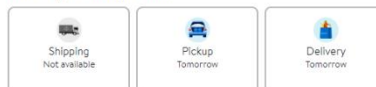
★★★★☆ (2.2) 211 reviews

\$5.97 \$5.97/lb

Price when purchased online ⓘ

Add to cart

How do you want your item?



Pickup from Bradenton Supercenter | Aisle A34

Delivery to Bradenton, 34207

EBT eligible

Add to list

Add to registry

Figure 4



Nutrition Facts Servings: 16,
Serv. size: 1 cup (240mL), Amount per
 serving: **Calories 130,** **Total Fat** 5g (6% DV),
 Sat. Fat 3g (15% DV), Trans Fat 0g, Polyunsat. Fat 0g, Monounsant. Fat 1.5g, **Cholest.**
 20mg (7% DV), **Sodium** 130mg (6% DV), **Total Carb.** 12g (4% DV), Fiber 0g (0% DV),
 Total Sugars 12g (Incl. 0g Added Sugars, 0% DV), **Protein** 8g, Vit. D (10% DV), Calcium
 (25% DV), Iron (0% DV), Potas. (8% DV), Vit. A (15% DV). %DV = % Daily Value



Best seller Popular pick for "milk 2%"

Great Value

Great Value 2% Reduced Fat Milk, 128 Fl Oz

★★★☆☆ (2.9) [4943 reviews](#)

\$2.83 2.2 ¢/fl oz

Price when purchased online ⓘ

Add to cart

How do you want your item?



Shipping
Not available

 Pickup Tomorrow

Delivery
Tomorrow

Pickup from Bradenton Supercenter | Aisle A31

Delivery to Bradenton, 34207

Figure 5



Nutrition Facts	
about 7 servings per container	
Serving size	3/4 cup (85g)
Amount per serving	
Calories	35
% Daily Value*	
Total Fat 0g	0%
Saturated Fat 0g	0%
Trans Fat 0g	0%
Cholesterol 0mg	0%
Sodium 15mg	1%
Total Carbohydrate 7g	3%
Dietary Fiber 2g	7%
Total Sugars 2g	
Includes 0g Added Sugars	0%
Protein 2g	
Vitamin D 0mcg	0%
Calcium 26mg	0%
Iron 0.7mg	4%
Potassium 217mg	4%



Popular pick for "broccoli stir fry"

Great Value

Great Value Frozen Broccoli Stir Fry, Mixed Vegetables,
20 oz Bag

★☆☆☆☆ (2.4) [113 reviews](#)

\$2.54 12.7 ¢/oz

Price when purchased online ⓘ

Add to cart

How do you want your item?

Shipping
Not available

 Pickup Tomorrow

Delivery
Tomorrow

Pickup from Bradenton Supercenter | Aisle A5

Delivery to **Bradenton, 34207**

EBT EBT eligible

 [Add to list](#)


 [Add to registry](#)

Figure 6

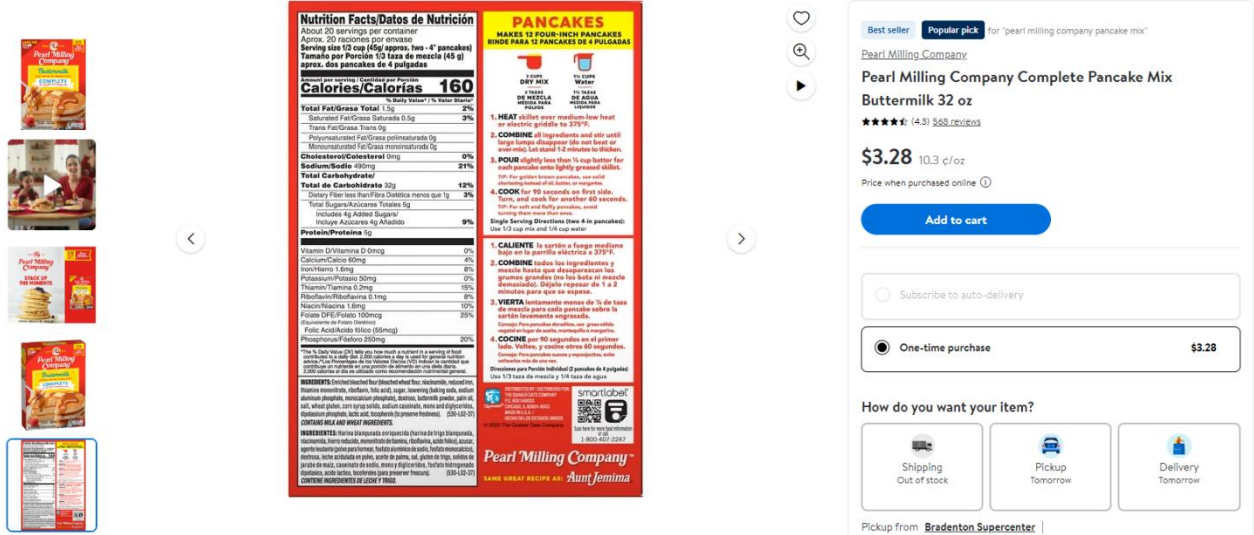


Figure 7

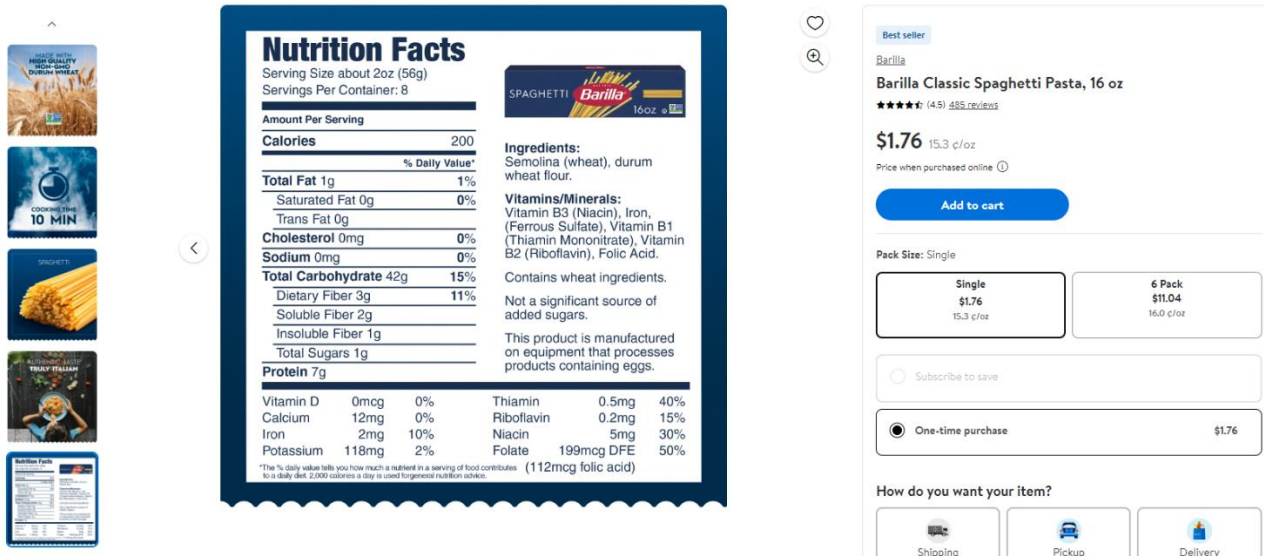


Figure 8

Nutrition Facts
Serving size **1 Bar (60g)**

Amount per serving
Calories 240

	% Daily Value*
Total Fat 15g	19%
Saturated Fat 8g	40%
Trans Fat 0g	
Polyunsaturated Fat 1.5g	
Monounsaturated Fat 4g	
Cholesterol 5mg	2%
Sodium 260mg	11%
Total Carbohydrate 23g	8%
Dietary Fiber 12g	43%
Total Sugars 2g	
Includes 0g Added Sugars	0%
Glycerin 8g	
Protein 16g	20%
Vit. D 0mcg 0%	Calcium 60mg 4%
Iron 1.6mg 8%	Potas. 220mg 4%

* The % Daily Value (DV) tells you how much a nutrient in a serving of food contributes to a daily diet. 2,000 calories a day is used for general nutrition advice.

No Maltitol

INGREDIENTS: PROTEIN BLEND (SOY PROTEIN ISOLATE, COLLAGEN, WHEY PROTEIN ISOLATE, WHEY PROTEIN CONCENTRATE), POLYDEXTROSE, PEANUTS, VEGETABLE GLYCERIN, PALM KERNEL AND PALM OIL, NATURAL FLAVORS, WATER, CELLULOSE POWDER, COCOA POWDER (PROCESSED WITH ALKALI), CONTAINS LESS THAN 2% OF: PEANUT OIL, SOY LECITHIN, BUTTERFAT, OLIVE OIL, SALT, MILK, GUAR GUM, SUCRALOSE.

CONTAINS MILK, SOY, PEANUTS.

MADE IN A FACILITY THAT ALSO USES EGGS, WHEAT, AND TREE NUTS.

Contains a Bioengineered Food Ingredient

Learn more about net carbs at **atkins.com**

*TOTAL CARBS (23g) - FIBER (12g) - GLYCERIN (8g) =
3g ATKINS NET CARBS

100+ bought since yesterday, try auto-delivery

Best seller

Atkins

Atkins Chocolate Peanut Butter Protein Meal Bar, High Fiber, Meal Replacement, Keto Friendly, 5 Pk

★★★★ (4.3) 580 reviews

\$8.98 84.7¢/oz

Price when purchased online

Add to cart

Subscribe to auto-delivery \$8.98

Get it on time, every time
Never run out with a subscription.
[How it works](#)

One-time purchase \$8.98

How do you want your item?

Figure 9

Gluten Free **Non GMO Project Verified**

50 SERVINGS PER CONTAINER

NO ARTIFICIAL FLAVORS OR COLORS

Mahatma
AMERICA'S FAVORITE RICE
Extra Long Enriched Rice
Arroz de Grano Largo Enriquecido

Nutrition Facts
About 50 servings per container
Serving size 1/4 cup (45g)

Amount per serving
Calories 160

	% Daily Value*
Total Fat 0g	0%
Saturated Fat 0g	0%
Trans Fat 0g	
Cholesterol 0mg	0%
Sodium 0mg	0%
Total Carbohydrate 36g	13%
Dietary Fiber 1g	4%
Total Sugars 0g	
Includes 0g Added Sugars	0%
Protein 3g	
Vitamin D 0mcg	0%
Calcium 0mg	0%
Iron 1mg	6%
Potassium 50mg	2%
Thiamin 0.2mg	15%
Niacin 2mg	15%
Folate 118mcg DFE	30%
(88mcg from food)	

*The % Daily Value tells you how much a nutrient in a serving of food contributes to a daily diet. 2,000 calories a day is used for general nutrition advice.

INGREDIENTS: Enriched Long Grain Rice

Best seller

Mahatma

Mahatma Enriched White Rice, Extra Long Grain Rice, 5 lb Bag

★★★★ (4.2) 272 reviews

\$4.98 6.2¢/oz

Price when purchased online

Add to cart

Pack Size: Single

Single \$4.98 6.2¢/oz

2 Pack \$10.48 13.3¢/oz

Subscribe to auto-delivery

One-time purchase \$4.98

How do you want your item?

Figure 10