Problem 2

1. Formulate as a linear problems:

Let: X1 = 100g of Tomatos

X2 = 100g of Lettuce

X3 = 100g of Spinach

X4 = 100g of Carrots

X5 = 100g of Sunflower Seeds

X6 = 100g of Smoked Tofu

X7 = 100g of Chickpeas

X8 = 100g of Oil

Minimize Z = 21X1 + 16X2 + 40X3 + 41X4 + 585X5 + 120X6 + 164X7 + 884X8

Where Z = number of calories (kcal)

Constraints:

0.85X1 + 1.62X2 + 2.86X3 + 0.93X4 + 23.4X5 + 16X6 + 9X7 ≥ 15g Protein

2g Fat ≤ 0.33X1 + 0.2X2 + 0.39X3 + 0.24X4 + 48.7X5 + 5X6 + 2.6X7 + 100X8 ≤ 8g Fat

4.64X1 + 2.37X2 + 3.63X3 + 9.58X4 + 15X5 + 3X6 + 27X7 ≥ 4g Carbohydrates

9X1 + 28X2 + 65X3 + 69X4 + 3.8X5 + 120X6 + 78X7 ≤ 200mg Sodium

(X2 + X3) / (X1 + X2 + X3 + X4 + X5 + X6 + X7 + X8) ≥ 0.4

Xi ≥ 0 for all i

Solution to the salad with minimum calories while still meeting nutritional requirements:

Tomato 0g

Lettuce 58.548g

Spinach 0g

Carrot 0g

Sunflower Seeds 0g

Smoked Tofu 87.822g

Chickpeas 0g

Oil 0g

Code used in Lindo 7:

MIN 21 X1 + 16 X2 + 40 X3 + 41 X4 + 585 X5 + 120 X6 + 164 X7 + 884 X8

ST

0.85 X1 + 1.62 X2 + 2.86 X3 + 0.93 X4 + 23.4 X5 + 16 X6 + 9 X7 > 15

0.33 X1 + 0.2 X2 + 0.39 X3 + 0.24 X4 + 48.7 X5 + 5 X6 + 2.6 X7 + 100 X8 > 2

0.33 X1 + 0.2 X2 + 0.39 X3 + 0.24 X4 + 48.7 X5 + 5 X6 + 2.6 X7 + 100 X8 < 8

4.64 X1 + 2.37 X2 + 3.63 X3 + 9.58 X4 + 15 X5 + 3 X6 + 27 X7 > 4

9 X1 + 28 X2 + 65 X3 + 69 X4 + 3.8 X5 + 120 X6 + 78 X7 < 200

X2 + X3 - 0.4 X1 - 0.4 X2 - 0.4 X3 - 0.4 X4 - 0.4 X5 - 0.4 X6 - 0.4 X7 - 0.4 X8 > 0

X1 > 0

X2 > 0

X3 > 0

X4 > 0

X5 > 0

X6 > 0

X7 > 0

X8 > 0

END

The cost of the Low Calorie Salad is $2.33 ($2.327283 to be exact)

1. Formulate as a linear problems:

Let: X1 = 100g of Tomatos

X2 = 100g of Lettuce

X3 = 100g of Spinach

X4 = 100g of Carrots

X5 = 100g of Sunflower Seeds

X6 = 100g of Smoked Tofu

X7 = 100g of Chickpeas

X8 = 100g of Oil

Minimize Z = X1 + 0.75X2 + 0.5X3 + 0.5X4 + 0.45X5 + 2.15X6 + 0.95X7 + 2X8

Where Z = cost in dollars

Constraints:

0.85X1 + 1.62X2 + 2.86X3 + 0.93X4 + 23.4X5 + 16X6 + 9X7 ≥ 15g Protein

2g Fat ≤ 0.33X1 + 0.2X2 + 0.39X3 + 0.24X4 + 48.7X5 + 5X6 + 2.6X7 + 100X8 ≤ 8g Fat

4.64X1 + 2.37X2 + 3.63X3 + 9.58X4 + 15X5 + 3X6 + 27X7 ≥ 4g Carbohydrates

9X1 + 28X2 + 65X3 + 69X4 + 3.8X5 + 120X6 + 78X7 ≤ 200mg Sodium

(X2 + X3) / (X1 + X2 + X3 + X4 + X5 + X6 + X7 + X8) ≥ 0.4

Xi ≥ 0 for all i

Solution to the salad with minimum calories while still meeting nutritional requirements:

Tomato 0g

Lettuce 0g

Spinach 83.2298g

Carrot 0g

Sunflower Seeds 9.6083g

Smoked Tofu 0g

Chickpeas 115.2365g \*see note below

Oil 0g

\*note – Lindo 7 report gave Chickpeas answer as 115.2364, but on double checking values this caused Protein = 14.99999g and Fat = 7.999987. This appears to be a rounding displace issue with numbers with long decimal values. Increasing either Sunflower Seeds or Chickpeas by 0.0001 would cause Protein to reach 15g, but Sunflower Seeds would also cause Fat to go over 8g, so I have incremented Chickpeas in the solution above. The change to price ($0.000001) and calories (0.0002 kCal) is very small.

Code used in Lindo 7:

MIN X1 + 0.75 X2 + 0.5 X3 + 0.5 X4 + 0.45 X5 + 2.15 X6 + 0.95 X7 + 2 X8

ST

0.85 X1 + 1.62 X2 + 2.86 X3 + 0.93 X4 + 23.4 X5 + 16 X6 + 9 X7 > 15

0.33 X1 + 0.2 X2 + 0.39 X3 + 0.24 X4 + 48.7 X5 + 5 X6 + 2.6 X7 + 100 X8 > 2

0.33 X1 + 0.2 X2 + 0.39 X3 + 0.24 X4 + 48.7 X5 + 5 X6 + 2.6 X7 + 100 X8 < 8

4.64 X1 + 2.37 X2 + 3.63 X3 + 9.58 X4 + 15 X5 + 3 X6 + 27 X7 > 4

9 X1 + 28 X2 + 65 X3 + 69 X4 + 3.8 X5 + 120 X6 + 78 X7 < 200

X2 + X3 - 0.4 X1 - 0.4 X2 - 0.4 X3 - 0.4 X4 - 0.4 X5 - 0.4 X6 - 0.4 X7 - 0.4 X8 > 0

X1 > 0

X2 > 0

X3 > 0

X4 > 0

X5 > 0

X6 > 0

X7 > 0

X8 > 0

END

There are 278.4882 kCal in the salad given in the solution above.

There are two ways I could see approaching this problem:

* 1. Add a constraint of Cost being under $2.00 for the salad and solve for minimum calories;

OR

* 1. Add a constraint of Calories being under 250kCal and solve for minimum cost

In our world Veronica is greedy and wants to make the most profit possible on her low-calorie salad. So she took approach b) above and her ingredient list will end up like so:

Tomato 0g

Lettuce 0g

Spinach 76.1996g

Carrot 0g

Sunflower Seeds 9.383g

Smoked Tofu 16.8942g

Chickpeas 88.0222g

Oil 0g

This will give a salad with 249.9998kCal at a cost of $1.622658