Diet Problem

Math Model & Decision Analysis Assignment 1

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Introduction

I am personally interested in LCHF (Low-Carbohydrates High-Fat) diet. I think solving this problem which fitted to my personal condition, would benefit to my health. There are several requirements for this diet:

- Ideal ratio of having Carbohydrates: Protein: Fat is 1:2:7
- Carbohydrates consumption must not exceed 50g per day. (Moderate level)
- Lower Carbohydrates is good.
- Total amount of calories should be over 3000 calories.
- There is no cap in how much eating, but shouldn't exceed 5000 calories per day.

These are the basic rules and I will introduce more about the LCHF diet.

I selected cost effective foods that fits in my taste are the followings:

- Rice, Egg, Cheese, Pork Belly, Roasted whole chicken

Below table is summarizing the nutrients of the following

Food	Serving Size	Cost per serving (AUD)	Energy (Cal)	Carbon (g)	Protein (g)	Fat (g)
Rice	100g	2.75	130.0	28.0	2.7	0.3
Egg	44g	0.38	68.2	1.1	5.7	4.8
Cheese	100g	4.20	402.0	1.3	25.0	33.0
Pork Belly	250g	5.37	1295.0	0.0	22.5	132.5
Roasted Chicken	Whole chicken	6.00	239.0	0.0	24.0	13.4

Method

Our aim for this linear programming is to minimize cost for LCHF diet. Let:

x1	Rice
x2	Egg
x3	Cheese
x4	Pork Belly
x5	Roasted Chicken

Our objective function is:

(Objective function) $\text{Minimize } z = 2.75\,x1 + 0.38\,x2 + 4.20\,x3 + 5.37\,x4 + 6.00\,x5$

Where z is daily total cost. We have constraints:

(Calories) $130\,x1 + 68.2\,x2 + 402\,x3 + 1295\,x4 + 239\,x5 \geq 2800$

(Carbohydrates) $28\,x1 + 1.1\,x2 + 1.3\,x3 \geq 50$

(Protein) $2.7\,x1 + 5.7\,x2 + 25.0\,x3 + 22.5\,x4 + 24.0\,x5 \geq 100$

(Fat) $0.3\,x1 + 4.8\,x2 + 33.0\,x3 + 132.5\,x4 + 13.4\,x5 \geq 350$

(Non-Negativity) $x1, x2, x3, x4, x5 \geq 0$

Since I want to have variety of foods, there will be restriction on minimum amount of food intake for each food.

(Rice) $x1 \geq 1$

(Egg) $x2 \geq 2$

(Cheese) $x3 \geq 0.1$

(Pork Belly) $x4 \geq 0.5$

(Roasted Chicken) $x5 \geq 0.5$

I will solve this linear programming problem with Excel Open Solver.

Results

Food	Serving	Measurement
Rice	1.59	159g
Egg	4.82	4.82
Cheese	0.1	10g
Pork Belly	2.388	597g
Roasted Chicken	0.5	Half Chicken

$22.45 AUD for daily foods.

Nutrients	Amount
Calories	2800

Carbohydrates	50
Protein	100
Fat	350

Binding constraints were: Carbohydrates, Protein, Fat, Cheese and Chicken.

Foods	Name	Final Value	Objective Value	Allowable Increase	Allowable Decrease
Rice	x1	1.5916949	2.75	1.983065307	2.637265688
Egg	x2	4.8204946	0.38	0.600638375	0.077906137
Cheese	x3	0.1	4.2	1E+100	2.421385144
Pork B	x4	2.3878047	5.37	2.155827318	4.276103015
Chicken	x5	0.5	6	1E+100	5.102908923

Name	Final Value	Shadow Price	RHS Value	Allowable Increase	Allowable Decrease
Carbohydrates Fat (g)	50	0.096238351	50	142.5265812	16.21449594
Protein Fat (g)	100	0.016295497	100	72.00571184	13.48432075
Fat Fat (g)	350	0.037761142	350	79.40766667	107.4068474
Calories Fat (g)	3787.5851	0	2800	987.5850971	1E+100
Rice Fat (g)	1.5916949	0	1	0.591694857	1E+100
Egg Fat (g)	4.8204946	0	2	2.820494562	1E+100
Cheese Fat (g)	0.1	2.421385	0.1	0.699639739	0.1
Pork Belly Fat (g)	2.3878047	0	0.5	1.887804661	1E+100
Roasted Chicken Fat (g)	0.5	5.1029088	0.5	0.620695675	0.5

Overall, Pork Belly was the most effective way of fulfilling fats. Egg was the most efficient protein food comparing the price.

References

(USDA Food Composition Database, n.d.)

https://ndb.nal.usda.gov