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Lean Muscle Gain Diet – A Study From The Saudi Food Market

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Abstract: People become more concerned about their eating habits, especially when the food choices become harder to considered from such as the types and the prices which will affect the quality of the food. Operation research is a management science that changes the problem into mathematical equations to make it easier to solve and choose the optimal solution. By using linear programming to optimize the prices and the choices of food at its best. Operation research has many applications in life, this design will give an easier understanding of the problem, use of computer programs such as QM to solve problems that have more than three variables. This paper will make use of QM to get results in detail and graphs if possible. Thus, the design of cheap and possible lean muscle gaining diet is made easier for men who live in Jeddah. The nutrition food that used in this paper and helps people to build muscle are energy, vitamin b1, proteins, vitamin b3, carbohydrates, vitamin b6, vitamin b12, zinc, vitamin c, and calcium. The minimum optimal solution of this study is13.81 when milk = 0.5, eggs =1.78, oranges=0.8, brown bread = 7.67 and spaghetti pasta = 13.57. The recommendation of this diet is that males who are looking to increase muscle mass and want to reduce overall cost without the risk of losing the health benefits.
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1. Introduction

People become more concerned about their eating habits, especially when the food choices become harder to considered from such as the types and the prices which will affect the quality of the food. Operation research is about getting the optimal solution by formulating and solving a mathematical model consisting of a number of equations to achieve an objective regarding maximization or minimization. Making a diet can be hard because designing a diet should be consistent and detriment which is optimal for maintaining a healthy and controlled life. In this paper, designing a lean muscle gaining diet from 10 to 30 foods by using linear programming to minimize the cost and maintaining muscle growth. The sample that has been used in this research is a male between 20-25 years old. The first step in this research is starting to make literature reviews to collect some information about similar diets and the component of a lean muscle diet. After that, calculating Basal Metabolic Rating. The next step is presenting the ingredients of the lean muscle diet and Nutrition and calories, name and address of each store, list of the nutrient facts and constraints of the diet such as; calories, protein, minerals, and vitamins. In the case study part, the diet has been discussed thoroughly to start creating the linear programming model.

2. Literature review

Operation research seeks to maximize the efficiency and deliver the best and optimal solution of any specific problem by converting the problem into a mathematical equation then solve it. By applying this method into the diet, it should give the best choices of foods with the best nutritious value with the lowest possible cost. It has some methods to maximize efficiency (Robert Dorfman et al., 1987). One of the methods of operation research is the Linear programming (LP) model that can help to convert the nutrition data and prices in this research into mathematical equations with the help of previous scientific papers and researches to make the solutions firm and trusted (George B Dantzig, 1991). In this paper, the diet will show how the cost of the food has a huge impact on nutrition's value. and that's clear among low socioeconomic groups, whenever lowering the cost constrain it will lower the food quality. Because food such as meat and the other type of protein will cost more but it could be replaced partially by some carbs and sweet like cereal, and how each type of food will affect the cost and the quality of food and that's the main idea. By applying LP methods, it will be easier to conduct the most suitable cost after minimization without damaging the nutrition requirement that the person needs to be

healthy (Nicole Darmon et al., 2002). There will be a specific constraint of diet for one person in this type of diet. this paragraph is talking about equality constraint on calories, lower bounds on protein, calcium, and vitamin C, iron and maximum bound of cholesterol per day. There was a study that was done in Italy said that the minimum amount of calcium was 800 grams, Vitamin C (66mg), Protein (95.3 g) and iron that between a range from 11 to 20 mg for person at day, that study also it's said that the maximum amount of cholesterol Almost within limits of 269mg for person at day (Conforti, Piero at al., 2000). The American food organization advises people on the importance of food and put many of the systems of food, including a diet based on 2000 price preservative and contains 9 meals daily 4 meals of fruits and 5 meals of vegetables, for the importance of fruits and vegetables for containing some metals such as (Potassium, Magnesium) and Vitamins such as (vitamin C, folic acid). This diet is very useful for the body and health and reduces the line. The diet of vegetables and fruits is considered a healthy, extremely beneficial food and cost-effective. (Rui Hai et al., 2013) An adequate diet is a great example of healthy low cos diet. In this diet, the minimum cost is certainly assured by the nutritive qualities and the cost of the foods qualified for including such as Calories, protein, calcium, iron, vitamin (A, C, B) and thiamine (B1). The National Research Council has a quantity for these nutritive as follows 3000 Calories, 70 grams of protein, 0.8 grams of calcium, 12 milligrams of iron, 5000 international units of vitamin A, 1.8 milligrams of thiamine (B1). Depend on the National Research Council the minimum cost for an adequate diet was almost $90 per person per month (George J. Stigler 1945) After having another plan called thrifty food, this model of making health benefits while maintaining a minimum cost. This model achieves this goal by discarding the barriers of American eating behaviors. It also separates lower income from higher-income families by the quality of the food, because the low budget is forced to buy canned food, fatty meat and frozen fruits in contrast to the higher budgeting family where they can buy fresh fruits, vegetables, red meat, and, seafood. (Hanson K et al.) Thus, in 2008 the results of this method were estimated at $588 every month. This model aims to maximize all the aspects of the Snap program. This program is based on nutrients such as vitamins A, C, E, D, proteins, fibers, and minerals such as iron magnesium and calcium. While minimizing fatty meat, sugar, and sodium. The model got 100 kilocalories for each serving (Drewnowski, Adam et al., 2010). When data were collected from adults over the age of 18 years, it has become clear that the most expensive diet of food ingredients are meat, eggs, and fish. On the hand, in this study, the lowest cost is fat and sweet. For fat and sweets, the LP diets cost is 2.52 euros per day. these foods will contain of Vitamin C 45mg/d, Calcium 700 mg/d, Iron 9 mg/d, Protein 56 g/d, Magnesium 255 mg/d and Zinc 9.5 mg/d. these are the mean of each one for persons. The summary of this is the total cost for men Is 2.52 euro per day and for women is 1.78 euro per day (Henson, Spencer 1991).

This study was conducted on adults who were over 18 years old and is show that some extra nutrients are important for lean muscle growth when exercising. creatine is one of the important components which exist in beef that can help to gain muscles. β-Hydroxy β-Methyl butyrate which is known as HMB is another important component that exists in beef and fish that help to repair the muscles and the recovery process. (Nissen, Steven L. et al., 2003) Carbohydrate is important to gain muscles not only protein. A complex carbohydrate is the best choice because it burns slowly and that will lead to getting energy for a longer time. Carbohydrate can be obtained from brown rice and brown bread. Carbohydrates are the main source for energy so, should take small amount often per day. Also, Fiber is needed to build muscles and the fiber makes muscle tissue get high amino acids faster. (Sacks FM et al., 2009).

Table 1. Ingredients from a local grocery store.

No.	Items/Ingredients
1	milk powder
2	Eggs
3	Ground beef
4	Greek yogurt
5	Chicken breast
6	Oranges
7	Tuna
8	Fish fillet
9	Milk
10	Brown rice
11	Shrimp
12	Spaghetti Pasta

3. Calculating basal metabolic rating

The utilizing of the basal metabolic rating is important for every human being. Thus, measuring the daily calorie intake is vital in gaining lean muscle mass and maintaining a constant healthy weight. The BMR calculates the energy needed for the body in the idle state. While the basal metabolic rating measures the energy required for the body, it sometimes fails to accurately measure the calories because of being under pressure or actively working and moving around in workplace. There is more than one equation

for calculating the BMR needed for the body such as the Harris-Benedict, Katch Mc Ardle, and Mifler Joer. The Mifler equation is the most used one for measuring daily energy needed (Johnstone AM at al., 2005).

3.1 Mifler equation: (BMR) for men.

〖(Height〗 _ ((Cm)) × 6.25+ 〖Weight〗 _ ((Kg)) × 10+ 〖Age〗 _ ((years)) × 5)+5.

Using this formula for male's in 22 years old, 178cm and 60kg, the results are as following:

=1,822 Calories/day.

Considering this result, calories intake should be added by 1600 calories to gain 1kg of body mass per week. The result should be 1,822 + 1600 = 3,422 calories/day.

Calculating the protein intake is measured by using a formula as simple as the Basal Metabolic Rating formula. (13)

The formula for calculating protein intake:

(〖2 to 3〗 _g of protein × 〖body weight〗 _Kg).

Using this formula to measure the same male whose weight is 60kg and willing to increase lean muscle growth. Thus taking 30% of total calorie intake in protein, the results are:

((0.3 protein × 〖3,422〗 _ (cal/day))/4)=257g of protein/day.

The formula for calculating fat:

(0.2 to 0.3 of total calorie per day).

saturated fat allowed (10%)= <40g.

The formula for calculating carbohydrates:

(0.4 to 0.45 of total calorie per day).

=512.44g.

Table 2. The required amount of nutrient.

Proteins	257g
Fibers	30g
Vitamins:	
Niacin (B3)	16mg
Vitamin B6	1.3mg
Vitamin C	45mg
Minerals:	
Calcium	1000mg
Magnesium	400 mg
Iron	8mg
Zinc	14mg
Sodium	460 mg
Energy/calorie	3,422 calories

4. Diet ingredients

Measuring the energy needed for the human body is not enough to make a diet. The diet ingredients should be chosen the first hand and picked carefully to make sure there are enough nutrients in the diet made. The items for the diet is chosen to improve protein intake and make sure the body gains lean muscle mass. These ingredients are found in a local grocery store market on September 2018. The table below shows the ingredients for this diet:

Table 3. The values of nutrient and the prices of each variable.

	Item	Energy Kcal	Magnesium Mg	Protein g	Vitamin b3 Mg	Carbohydrates g	Vitamin b12 Ug	Sodium mg	Zinc mg	Fiber g	Vitamin c mg	Calcium mg	Price SAR / 100g
1	Powdered Milk	493	85	26.3	5.3	39.8	1.8	350	4.5	0	50	1300	5.125
2	Egg	143	35	12.6	0.1	3.2	1.3	480	1.1	0	0	53	0.93
3	Beef	145	27	25.1	4.9	0	2.6	75	6	0.1	0	17	5.04
4	Greek Yogurt	99	0	10	0	14	0	0	0	0	0	115	1.94
5	Chicken breast	88	24	19.5	13.7	0	0.3	28	1	0	0	15	4.2
6	Oranges	47	22	0.9	0.3	11.7	0	3	0.4	0	53.2	40	0.381
7	Tuna	224	50	25.9	13.3	0.96	3	400	0.8	0	0	11	4.57
8	White fish fillet	124	0	23.42	3	0	1	0	1	0.5	0	26	3.49
9	Brown bread	263.7	19	9.1	4	45.3	0	415.1	1.5	6.6	0	33	1.065
10	Brown rice	361.7	143	8.8	8.82	72.1	0	360	0.6	1.8	0	6.9	1.19
11	Shrimp	92.56	17	19.25	2.6	0	1.5	224	1.9	4	2.2	39	4.26
12	Spaghetti pasta	345	119	12	0	70	0	2	0	0	0	41	0.25
QTY (Required amount)		3422	400	257	16	512.44	2.4	460	14	30	45	1000	

5. Nutrition and calories

The human body needs a certain amount of nutrition and energy to keep going such as protein, carbohydrates, fat, fiber and sugars. If this nutrition monitored carefully that amount will help the body to gain a lean muscle. In addition, there are required minerals and vitamins that might affect the muscle such as protein, Fluids, Fiber, Thiamin, Niacin, Vitamin A, Vitamin B6, and Vitamin B12. Table (2) shows the required amount of nutrient.

6. Case study

Making a diet for a male adult that wants to increase lean muscle growth and maintaining a cheap price is set by getting the required amount of nutrition such as; proteins at least 257g, fluids at least 2.3L, fibers at least 30g and vitamins at least; thiamin (B1) 1.2mg, niacin (B3) 16mg, vitamin B6 1.3mg, and vitamin C 45mg. Minerals also play an important role for healthy bones so the amount of calcium is at least 1000mg, iron no less than 8mg and zinc at least 14mg. keeping in mind the total amount of calories should be at least 3,422 calories per day.

7. Linear programming method

After acquiring the nutrition facts and what type of food ingredient needed for the diet, it was arranged In Table (Rui Hai Liu et al., 2013). This table shows the values of nutrient and the prices of each variable that is acquired from a local grocery store.

8. The objective function and constraints in the LP model

Objective	Constraint
Minimization cost	$Z = 5.125\ X_1 + 0.93\ X_2 + 5.04X_3 + 1.94X_4 + 4.2X_5 + 0.381X_6 + 4.57X_7 + 3.49X_8 + 1.065X_9 + 1.19X_{10} + 4.26X_{11} + 0.25X_{12}$

Subject to

No.	Constraint
1	$493X_1 + 143X_2 + 145X_3 + 99X_4 + 88X_5 + 47X_6 + 224X_7 + 124X_8 + 263.7X_9 + 361.7X_{10} + 92.56X_{11} + 345X_{12} \geq 3422$
2	$85X_1 + 35X_2 + 27X_3 + 24X_5 + 22X_6 + 50X_7 + 19X_9 + 143X_{10} + 17X_{11} + 199X_{12} \geq 400$
3	$26.3X_1 + 12.6X_2 + 25.1X_3 + 10X_4 + 19.5X_5 + 0.9X_6 + 25.9X_7 + 23.42X_8 + 9.1X_9 + 8.8X_{10} + 19.25X_{11} + 12X_{12} \geq 257$
4	$5.3X_1 + 0.1X_2 + 4.9X_3 + 0X_4 + 13.7X_5 + 0.3X_6 + 13.3X_7 + 3X_8 + 4X_9 + 8.82X_{10} + 2.6X_{11} + 0X_{12} \geq 16$
5	$39.8X_1 + 3.2X_2 + 14X_4 + 11.7X_6 + 0.96X_7 + 45.3X_9 + 72.1X_{10} + 70X_{12} \geq 512.44$
6	$1.8X_1 + 1.3X_2 + 2.6X_3 + 0.3X_5 + 3X_7 + 1X_8 + 1.5X_{11} \geq 2.4$
7	$350X_1 + 480X_2 + 75X_3 + 28X_5 + 3X_6 + 400X_7 + 415.1X_9 + 360X_{10} + 224X_{11} + 2X_{12} \geq 460$
8	$4.5X_1 + 1.1X_2 + 6X_3 + 1X_5 + 0.4X_6 + 0.8X_7 + 1X_8 + 1.5X_9 + 0.6X_{10} + 1.9X_{11} + \geq 14$
9	$0.1X_3 + 0.5X_8 + 6.6X_9 + 1.8X_{10} + 4X_{11} \geq 30$
10	$50X_1 + 53.2X_6 + 2.2X_{11} \geq 45$
11	$1300X_1 + 53X_2 + 17X_3 + 115X_4 + 15X_5 + 40X_6 + 11X_7 + 26X_8 + 33X_9 + 6.9X_{10} + 39X_{11} + 41X_{12} \geq 1000$

9. Results

The approach used to solve this kind of linear programming is by utilizing QM™ computer software, by inserting the data into the QM query and using the minimization approach to solve the data. After acquiring the results, it showed that one of the methods used to solve this data was the dual method. Using the dual approach is done by separating the data into two types primal and dual. The final result is as follows:

The minimum cost is 13.81 Riyals where milk powder = 0.5 Riyals, Eggs = 1.78 Riyals, Oranges = 0.8 Riyals, Brown Bread = 7.67 Riyals, Spaghetti Pasta = 13.57 Riyals

10. Conclusion and recommendations

In conclusion, applying a linear program by using QM has found that the best way to achieve an optimal diet while maintaining the daily nutrients required for males between 20-30 years. Also, keeping the cost at a minimum level. The recommendation of this diet is that males who are looking to increase muscle mass and want to reduce overall cost without the risk of losing the health benefits.

Linear Programming Results

	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12		RHS	Dual
Minimize	5.13	.93	5.04	1.94	4.2	.38	4.57	3.49	1.07	1.19	4.26	.25			
energy	493	143	145	99	88	47	224	124	263.7	361.7	92.56	345	>=	3422	0
magnesium	85	36	27	0	24	22	50	0	19	143	17	119	>=	400	0
protein	26.3	12.6	25.1	10	19.5	.9	25.9	23.42	9.1	8.8	19.25	12	>=	257	-.02
vitamin b3	5.3	.1	4.9	0	13.7	.3	13.3	3	4	8.82	2.6	0	>=	16	0
carbonydrat e	39.8	3.2	0	14	0	11.7	.96	0	45.3	72.1	0	70	>=	512.4 4	0
vitamin b12	1.8	1.3	2.6	0	.3	0	3	1	0	0	1.5	0	>=	2.4	-.01
sodium	350	480	75	0	28	3	400	0	415.1	360	224	2	>=	460	0
zinc	4.5	1.1	6	0	1	.4	.8	1	1.5	.6	1.9	0	>=	14	-.58
fiber	0	0	.9	0	0	0	0	.5	6.6	1.8	4	0	>=	30	0
vitamin c	50	0	0	0	0	53.2	0	0	0	0	2.2	0	>=	45	.0
calcium	1300	53	17	115	15	40	11	26	33	6.9	39	41	>=	1000	.0
Solution	.05	1.78	0	0	0	.8	0	0	7.67	0	0	13.57		13.81	

Figure 1. The result of this diet by using a linear programming method.

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