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| The University of Toledo | Brand Guide  **The Optimal Diet Plan**  [Document subtitle] | Abstract  The project aims at providing a wholesome diet plan for a dietitian’s clients. Uses excel solver to setting different objectives and constraints for various diet plans such as Paleo diet, Vegan diet, Muscle gain and weight loss diet plan.  Jesu, Jemimah  OSCM6350 Prescriptive Analysis |

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# **Background Of The Project**

Researchers suggest that rapid weight loss without considering a balanced diet can lead to slow metabolism, leading to future weight gain. Crash diets would also lead to weaken immune system, increase risk of dehydration and cardiac stress and other problems. Maintaining recommended nutrient level on your diet is very vital. Most of the diets fail in the long run, resulting in gaining back the lost weight.

Generally, diet plans only focus on the macronutrient’s proportions such as carbohydrates, fat and protein. Inclusiveness of both micro and macro-nutrients in all three meals is very important for a healthy lifestyle.

As an effort to ease this situation, this project aims at providing a wholesome meal making dieting effective in reducing weight and thus provide effective results in the long run.

# **Objectives Of The Project**

The objective of the project is to improve the overall nutrient intake of an individual while also taking food preferences of the clients into consideration. This is achieved by customizing the food menu i.e.., the raw data input for the excel solver. The diet plan is set in such a way that it not only includes all the nutrients, exactly at the level recommended by USDA but also maintains the right about of calorie deficit to achieve the desired weight.

# **Target And Expected Output Of The Project**

General features of the project are listed below.

Expected goals which will be attained after the project completion

1. Goal of the proposed plan

To provide a successful meal plan for clients that includes all nutrients while keeping in mind the calorie intake for weight loss/muscle gain.

1. Goal which will be attained by utilizing the proposed plan

To achieve the target weight with no side effects or health hazards caused by lack of nutrients. Helps to maintain the lost weight in the long run.

Outputs

1. The client receives a meal plan as per his/her type of diet plan
2. The plan includes the food, quantity to be consumed, how many times it must be consumed per day
3. The price of the meal can also be determined which helps the client not exceed his/her food budget.

Beneficiaries

Clients aiming to reduce weight by following paleo or vegan diet. Clients who focus on muscle gain consuming only lean meat. The constraints of the solver can be adjusted as per the BMI of the client and the data set can be adjusted as per the client’s food preference and availability.

# **Project Activity Flow**

The project activity consists of the following four components

1. Improve the raw data quality by data cleaning i.e., Filter unwanted outliers, structural errors, handle missing data, remove duplicate and irrelevant observation.
2. Identify deficit nutrients in a conventional diet plan and set them as the objective for the diet plan. i.e., vegan diets are low in protein and vitamin B12 intake.
3. Set the upper limit and lower limit constraints as per the nutrient recommended by the USDA.
4. Test run the excel solver and find improvements in the process by setting additional constraints.
5. Review the results and the feasibility reports to check if all constraints are fulfilled or violated.
6. Consolidate the output to step up a meal plan.

# **Mathematical Implementation**

The Diet Problem is formulated mathematically using linear programming problem as shown below.

**Sets**  
F = set of foods  
N = set of nutrients

**Parameters**  
aijaij = amount of nutrient content jj in food ii, ∀i∈F∀i∈F, ∀j∈N∀j∈N  
cici = calories per serving of food ii, ∀i∈F∀i∈F  
FminiFmini = minimum number of required servings of food ii, ∀i∈F∀i∈F  
FmaxiFmaxi = maximum allowable number of servings of food ii, ∀i∈F∀i∈F  
NminjNminj = minimum required level of nutrient jj, ∀j∈N∀j∈N  
NmaxjNmaxj = maximum allowable level of nutrient jj, ∀j∈N∀j∈N

**Variables**  
xixi = number of food servings ii to purchase/consume, ∀i∈F∀i∈F

**Objective Function**: Minimize/maximize the total calorie intake of the food  
Minimize ∑i∈Fcixi∑i∈Fcixi

**Constraint Set 1**: For each nutrient necessary for the diet  j∈Nj∈N, at least meet the minimum required level.  
∑i∈Faijxi≥Nminj,∀j∈N∑i∈Faijxi≥Nminj,∀j∈N

**Constraint Set 2**: For each nutrient necessary for the diet   j∈Nj∈N, do not exceed the maximum allowable level.  
∑i∈Faijxi≤Nmaxj,∀j∈N∑i∈Faijxi≤Nmaxj,∀j∈N

**Constraint Set 3**: For each food on the food menu i∈Fi∈F, select at least the minimum required number of servings.  
xi≥Fmini,∀i∈Fxi≥Fmini,∀i∈F

**Constraint Set 4**: For each food on the food menu i∈Fi∈F, do not exceed the maximum allowable number of servings.  
xi≤Fmaxi,∀i∈F

# **Interpreting The Solution**

In this project, there are two main constraints taken into consideration. It bounds on the minimum and maximum allowable number of servings for each food type and the allowable level of nutrients for each type of nutrient according to the USDA recommendations.

# **Implementation Of The Project**

A normal human being must consume at least 2000 calories to main his current weight. Basically, a calorie deficit i.e., consuming less than 2000 calories will result in weight loss and a calorie surplus i.e., consuming more than 2000 calories would result in weight gain. This makes dieting easily achievable, but that’s not where it all ends. Consuming right amount of both macro and micronutrient will help maintain the results in the long run.

**Vegan Diet Plan**

1. **Objective function**

Maximize the protein intake and consume the right amount of vitamin B12

MAXIMIZE ∑i∈Fpixi∑i∈Fpixi

xixi = number of food servings

pipi = Protein per serving of food ii, ∀i∈F∀i∈F

1. **Constraints**

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**Constraint 1** : each food item on the menu cannot be selected more than 3 times. The number 3 is taken considering a client having a vegan diet consumes 3 meals a day

For each food on the food menu **i∈Fi∈F**, do not exceed the maximum allowable number of servings.  
**xi≤Fmaxi,∀i∈F**

**Constraint 2**: This constraint is a non-negativity constraint and determines the minimum number of times a food item can be chosen.

For each food on the food menu **i∈Fi∈F**, select at least the minimum required number of servings.  
**xi≥Fmini,∀i∈Fxi≥Fmini,∀i∈F**

**Constraint 3** : This constraint sends the upper bound for all the necessary nutrients micro and macro nutrients.

For each nutrient necessary for the diet   **j∈Nj∈N**, do not exceed the maximum allowable level.  
**∑i∈Faijxi≤Nmaxj,∀j∈N∑i∈Faijxi≤Nmaxj,∀j∈N**

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**Constraint 4 :** This constraint sends the lower bound for all the necessary nutrients micro and macro nutrients.

For each nutrient necessary for the diet **j∈Nj∈N,** at least meet the minimum required level.  
**∑i∈Faijxi≥Nminj,∀j∈N∑i∈Faijxi≥Nminj,∀j∈N**

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***NOTE: The constraints for the nutrient intake for all four plans (vegan, Paleo, weight loss, muscle gain) remains to be the same. Whereas the objective for each of the diet plan varies. Keeping this in mind lets discuss on the objectives for the other three plans.***

**Paleo Diet Plan**

While paleo diet focuses on reducing weight by consuming lean meat. They consume good about of protein, fat and other macronutrients. According to USDA, paleo diet misses on calcium and vitamin D in their food. Considering this issue, our objective for paleo diet is maximizing the calcium intake level and maintaining it in the recommended levels.

1. **Objective function**

Maximize the calcium intake and consume the right amount of Calcium

MAXIMIZE ∑i∈Fpixi∑i∈Fpixi

xixi = number of food servings; cici = calcium per serving of food ii, ∀i∈F∀i∈F

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**Weight Loss Diet Plan**

1. **Objective function**

Minimize the total calorie intake of the food. As mentioned earlier, a calorie deficit would help to reduce obesity. The calorie intake can be adjusted in the constraints as per BMI of the client.

Minimize ∑i∈Fcixi∑i∈Fcixi

xixi = number of food servings; cici = calorie per serving of food ii, ∀i∈F∀i∈F

**Muscle Gain Diet Plan**

1. **Objective function**

Maximize the calorie intake and consume the right amount of calorie recommended to increase the weight. Increasing weight by consuming less fat and more protein is necessary for muscle gain. If not, surplus calorie would result in obesity.

 Maximize ∑i∈Fcixi∑i∈Fcixi

xixi = number of food servings; cici = calorie per serving of food ii, ∀i∈F∀i∈F

# **Result And Evaluation Of The Project**

The excel solver run the constraints and found an optimal solution for all four diet plans. All constraints and optimality conditions being satisfied.

We need to understand that each food item’s quantity is 100 grams per serving. The solver arrives at a list of food that can be consumed per day and not per meal. The solver is set in such a way that same food item is not chosen more than 3 times.

Vegan diet

Table

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This chart implies that client can consume 300 grams of cremini mushrooms (i.e.) 3\*100 =300 grams. This is because all servings are in 100 grams. And the decision variable says 3. Which implies the dish can be consumed thrice per day.

The objective is to maximize the protein content in food and to achieve the desired amount of vitamin B12. The recommended quantities of proteins and vitamins were hard to include in any conventional vegan diet.

Paleo Diet

Paleo diet includes high quality of protein and a powerhouse of nutrient in it.

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All constraints were met and the objective of maximizing calcium is achieved. While concentrating in a protein rich diet, often calcium and other necessary vitamins that can be gotten only from dairy products and vegetables are missed. Here we could see the recommended amount of all nutrients including calcium and vitamins are included in this balanced diet.

Fat loss diet

This diet plan is quite interesting than other plans. A vegan or a paleo diet has many dietary constraints such as no meat or no dairy products. But a regular fat loss diet has no such dietary restrictions and it’s a way where a client can eat all his favorite foods and still reduce body weight. If noticed the solver result also includes restaurant foods, sweet and baked foods. The nutrient recommendation and weight loss is also taken into consideration.

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Muscle gain

The composition of diets for body builders should be 55-60% carbohydrate, 25-30% protein and 15-20% of fat, for both the off-season and pre-contest phases. Keeping this in mind the following diet plan is structured.

Our diet plan consists of 60% carbs 25 % protein and 14% total fat. This is very appropriate for lean muscle building. Most of the traditional diet plan concentrate on these macro nutrients but miss out on the micronutrient factors. Which leads to weaken immune system and other chronic diseases. The excel solver results has the right mixture of both micro as well as macro nutrients in its weight loss plan.

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# **Conclusion and future Project Recommendations**

This project focuses on intaking the right quantity of macro and micronutrients while striving to reduce body weight. This plan can be modified easily for other BMI or any food preferences of clients.

Future projects can be done based on this diet plan using linear programming on excel Diet plan to formulate a balanced diet for a low-income person using price as the main objective. Many governments in low-income countries can formulated diet plans to eradicate poverty and death caused by starvation. Diet plans for army men and women can be formulated. Dietary plan for patients such as cancer patients who have plenty of dietary restrictions can also be effectively created at a given budget. The scope for this project to grow in various fields is tremendous and could be help millions of people in suffering.