Research Article

MATHEMATICAL REVIEWS ON OPTIMIZATION TECHINIQUE FOR DIETPLANNING PROBLEM: CASE STUDY ECZEMA PATIENT

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ABSTRACT

This paper shows different techniques use in operation research to encounter with various diet problems. Each diet problem has its respective cost restriction and objective functions. The planning adequate menus involves consideration of several types of constraints such as the desired nutritional content, the amount of food to be consumed and others. The mathematical models were built to decide a diet plan as optimal solution which satisfy all the requirements and restrictions. The application of different optimization approaches and drawback in each technique has been discussed. The paper also illustrates the use of integer programming and improvement that can be done. An optimal and practical solution is obtained to solve the diet problem of eczema patients.

INTRODUCTION

A balanced diet is vital for each humankind in order maintain good health and body condition. This diet includes a variety of foods to provide essential nutrients such as carbohydrate, proteins, vitamins, minerals, fat and fibres to our body. A well-planned balanced diet is even more crucial for those people who suffers from the Eczema. Food plays important role in affecting the eczema condition. A well-developed menu specified for eczema patients undoubtedly can help control and ease the eczema condition. However, there is some food commonly will trigger the allergic action of Eczema patients such as dairy product, shellfish, nuts. Besides, Eczema patients should limit to eat those foods containing high sugar level. The insulin levels will increase drastically which leads to inflammation. Salicylates are organic chemicals that serve as protection for vegetables and fruits against the pests and preservatives to prevent rot and disease. Eczema patients should avoid consuming the vegetables which are in high

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salicylate such as eggplant, broccoli, endive, radish and furthermore. Eczema is also known as atopic dermatitis is a kind of skin disease with a prevalence of 2-5% in children and teens nearly 10% in global (World Allery Organization, 2017). The eczema cases are in the increasing trend with the prevalence of eczema among primary school children was about 12-13% in 2001 (Leong, 2017). Lastly, there is 10-20% of children and two in every ten individuals in Malaysia suffered from eczema (The Star Online, 2017).

Eczema patients faced their problem in choosing the diet that meet the nutrition requirements. There is no research about conducting optimization approach in solving the diet problem of eczema patients. The diet planning for eczema patients involved the optimisation method in order to make better decision making to overcome this diet problem. And thereby, a proper and considerate planning diet for eczema patients can reduce and ease the eczema condition. Planning adequate menus involves consideration of several types of constraints: the desired nutritional content, the amount of food to be consumed and their food allergens.

Literature Review

The diet problem involves established mathematical model, application of optimization method to deal with problem, formulation of strategies and solutions (Czyzyk, 2016). The example of diet problem such as diet optimization for athlete. Two main objectives that is the panning menu meeting nutritional requirements of athletes and keep those expenditure allocated for athletes staying with the predetermined budget. The establishment of strong athletes' physical is heavily relied on the well-planned diet menu (Magdić, 2014).

Linear Programming

An optimization study is to investigate the food choice of French women to prepare the balanced meal with the cost constraint. The method used is linear programming modeling to find the food combination is optimal in nutrition with the lowest cost. The sample for this study consists of 476 of French women from different socioeconomic levels. The diets were developed by linear programming technique which is Simplex procedure of the Premium Solver Platform 5.0 for Excel (Darmon, 2014). A linear programming model to fulfill a week of predetermined nutritional requirements and cheapest packages combination of food such as chicken, macaroni, spaghetti and so on. The result obtained is a monotonous diet that included only 46.667 packages of macaroni and cheese with the lowest expenditure at \$88.20. This was not his desired solution. He then modified and developed an AMPL model for this diet problem. The diet adjusted are acceptable differ from previous results. The diet now comprises of 19.5 packages of chicken, 16.3 packages of macaroni and cheese, and 4.3 of meat loaf. However, the cost increased from \$88.20 to \$89.99. Such modification to the linear program will generate a more acceptable solution in solving the diet problem (Fourer, 2015). The application of Linear Programming Technique is in progress in many studies and fields.

feed compounds and in return to raise the productivity of fishes and minimise the cost (in Indian Rupee) for formulation of fish feed. The model was developed which consisted 7 variables which are theamount in kg of groundnut cake, soya bean cake, rice-bran, wheat bran, fish meal, brewer waste,til cake required for the formulation of the fish feed (Nath and Talukdar, 2016). The constraints for this model:

- Protein (not less than 38%)
- Lipid (not less than 6%)
- Carbohydrate (not less than 26%)
- Calcium (not less than 1 %)
- Phosphorous (not less than 0.6%)
- Amount needed (The sum for the food item as fish feed is 100kg)

In this case, the linear programming method to generate the feed formulation is more efficient and effective than the traditional method such as trial and error method that result in a lower productivity of fishes.

Integer Programming

Generally, the food items intake is in whole units in which an integer value is more representative than non-integer value. And thereby, integer programming is introduced to formulate the planning diets for humans at lowest cost. Besides that, logical is used to define the relationship among frequency of use of foods, exchange groups and the energy content of different meals. Subsequently, the linear equations that are used for describing these interactions were generated. The application of this algorithm is further developed the diet related problem based on numerous types of basic foods that meet the nutritional requirements for certain group of people. (Sklan and Dariel, 2010).

Table 1. Summary of Previous Study

Study	Technique	Research Problems
Darmon, Ferguson & Briend (2006)	Linear Programming	To investigate the food choice of French women from different socioeconomic levels to prepare the balanced meal with the cost constraint. The solution for the French women from low economic level may not practical, the meal planning is not familiar in their families and not designed according to their preference.
Fourer, Gay & Kernighan (2003)	Linear Programming	To generate a linear programming model to fulfill a week of predetermined nutritional requirements and cheapest packages combination of food such as chicken, macaroni, spaghetti and so on. The linear programming model could not satisfy all the constraints that leads to an optimal solution.
Nath & Talukdar (2014)	Linear Programming	To determine fish feed compounds and in return to raise the productivity of fishes and the profit earning by the fishes. In this case, the linear programming method to generate the feed formulation. The upper bounds for the nutrient contents do not consider in the research.
Patil & Kasturi (2016)	Integer Programming	Carried out the optimization research about the nutritional ingredient needed by the human who aged 40 to 45 and to minimize the total diet cost at the same time. The food items included in the research are limited.
Pasic et al. (2012)	Goal Programming	Proposed a model which to enhance healthy nutrition menu planning which within the household food budget expenditure. The menu planning is designed only for daily needs, and thus the food variety is not considered.
Eghbali et al. (2015),	Fuzzy Linear Programming	To generate a model for those patients this can satisfy their nutrition requirements in the fuzzy environment. The fuzzy concept is applied on account of the facts that there is uncertain in the amount of nutrients intake. There is some sentences when using this technique owing to that the fuzzy logic may not reflect the realities.
Mamat et al. (2012)	Fuzzy Linear Programming	Proposed a Fuzzy Linear Programming for planning diet menu for Eating Disorder and Disease-related lifestyle. Some macronutrients are not taken account in this research. Therefore, there is lack of nutrients in the menu planning.
Saxena (2011)	Nonlinear Programming	To construct a nonlinear programming model for optimising the use in nutrient ingredients in the diet planning. The nonlinear programming approach is impractical to apply since it encounters massive solution algorithms and complex mathematical theory.

The diet problem can be expressed as follow:

$$c_1 x_1 + c_2 x_2 + c_3 x_3 ... + c_n x_n \qquad \text{.............(2.1)}$$

Subject to the constraints:

$$a_{11} x_1 + a_{12} x_2 + a_{13} x_3 + ... + a_{1n} x_n \geq b_1,$$

$$a_{21} x_1 + a_{22} x_2 + a_{23} x_3 + ... + a_{2n} x_n \geq b_2,$$

$$a_{m1} x_1 + a_{m2} x_2 + a_{m3} x_3 + ... + a_{mn} x_n \geq b_m, \qquad \text{............(2.2)}$$

where a_{mn} is the value of constraint m in variable x_n.

The nutritional requirement of human differs from age to age. The optimization research was conducted about the nutritional ingredient needed by the human who aged 40 to 45 and to minimize the total diet cost at the same time. There are some nutritional constraints should be complied which is the range of certain nutrients requirements have been determined (Patil & S. Kasturi, 2012).

Table 2. Contributions and Improvement of the Research using Integer Programming

i.	To prepare menu to meet certain nutritional requirement
ii.	To determine the balanced nutrient that required by the eczema patients
iii.	To find the optimal and practical solution
iv.	To provide a complete menu planning for one day
v.	The range of nutritional requirements are defined.
vi.	Included all essential vitamin and minerals in the meal.
vii.	426 food items are considered into the daily menu planning
viii.	The solution is customized for the eczema patients

Goal Programming

Goal programming is an extension or generalisation of linear programming to handle multiple, normally conflicting objective measures. A model which to enhance healthy nutrition menu planning which within the household food budget expenditure (Pasic, 2011). This study was done in the capital of Bosnia and Herzegovina from February to March 2011 (two months period). 50 random samples of household were selected to answer the questionnaires. In that survey, the sample concerned consists of 55 most common consumed food items as decision variables. They then developed a goal programming model which is to reduce the deviation of World Health Organization recommended daily nutrients required to the greatest extend and subject to the household expenditure constraints. The objective function in this model using goal programming approach:

$$\text{Minimize Z} = \sum_{i=1}^{n} (d_i^- + d_i^+) \qquad \text{............(2.3)}$$

d_i^- and d_i^+ are positive and negative deviational variables that indicate the deviations from the ith goal. For the RNI constraints positive deviation $d_i^+ = 0$, while for the UL constraints negative deviation $d_i^- = 0$.

Fuzzy Linear Programming

Optimization method also can help to find the solution of diet problem faced by renal patients. Generally, the kidney disease become worsen when a patients intake too much salt, protein and others in the diet. And thus, Fuzzy Linear Programming is used to generate a model for those patients which can satisfy their nutrition requirements in the fuzzy environment. The fuzzy concept is applied on account of the facts that there is uncertain in the amount of nutrients intake. (Eghbali, 2013). TheApplication of Fuzzy Linear Programming in planning diet menu for Eating Disorder and Disease-related lifestyle. This approach involves the computation of the amount of nutrients required which subjected to some constraints (Mamat, 2015).

Nonlinear Programming

In the research of (Saxena, 2010), the nonlinear programming can solve the weakness of linear approximation of objective function for diet formulation. The assumptions for all variables are linear sometimes are not practical and result in limitation of solution for the diet problem. As well as linear programming, it can be used to design a model which generates the diet that yield the least cost. To formulate the nonlinear programming model, it involved a complex procedures which is the least square relation between responding variable and explanatory variables of different degrees are conducted. F-test is next applied to find the best fit relation among the variables.

DISCUSSION

This section will highlight the previous study and the disadvantages of each study. Then we will discuss the proposed technique and the development of the mathematical model of the Malaysian menu planning problem. Table 1 shows the comparison of previous study and the disadvantages of each study. Previous studies showed that several approaches have been deployed in the application of menu planning problem with various objectives and constraints. Further improvement need to be done and Table 2 describes the contributions that can be acknowledged in this research.

Conclusion

The expenditure of the food menu can be minimized by applying the integer programming approach. Besides ensuring the healthy diet which provides all the essential minerals and vitamins, the feasible solution also generated for the eczema patients to plan their diet menu according to the mathematical model. The study helped to understand the human nutrients requirements and the use of integer programming to get a considerate and optimal diet. The further study can be extended to prepare balanced diet menu that meets nutritional requirements and suitable for eczema patients at all ages or other diseases that required diet control. In addition, even more effort in conducting the research on exploring the knowledge of food intolerance, food and their respective nutritional value and to promote healthy lifestyle.

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