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Linear Programming and Its Application for Preparation of Product Mathri and Namkeen in a Small Scale Industries

Manmohan Patidar, Sanjay Choudhary*
Department of Mathematics, Govt. N.M.V. Hoshangabad
*Head, Department of Mathematics, Govt. N.M.V. Hoshangabad (M.P.), India
Email:manmohan80patidar@gmail.com

Abstract

The aim of the present research paper is to use the simplex algorithm of linear programming to find the maxim profit in the selling of Besan items such as Mathri and Namkeen. The target is to achieve maximum profit in small expenditure.

KEYWORDS: Linear programming model, Simplex method, Decision variables, Optimal result

I. Introduction and Basics Examples

OR is Basically is a Branch of Mathematics which provides a Solid Base to Management to take early and Effective Decision for any Organization Specially Applied in Mathematics application to provide a Scientific Base for Management to take timely and effective decisions to their Problems. In India, Operations research came into Existence with the Opening of an OR unit in 1949 at the Regional Research Laboratory in Hyderabad. The scope of Operations Research is wide and has been successfully applied in the following areas such as Industry, Defense, Planning, Agriculture and Public Utilities. Linear Programming is an approach in mathematics is widely used today the Programming Concept is use full to Allocate the Resources in a Proper way. 'programming' means taking decisions systematically. The Necessity of the work to use linear programming model determine the maximum profit while minimizing the cost.

Manny Researcher worked in the field of Operations Research to maximize the profit. According to Anieting et al (2013) reported that, applying linear programming technique to determine optimum production of Usmer Water Company. The authors Akpan et.al (2016) worked to utilized the concept of the simplex algorithm; an aspect of linear programming to allocate raw materials to competing variables (big loaf, giant loaf, and small loaf) in a bakery for the purpose of profit maximization. The researchers Raimi et al (2017) reported that, the optimization of bread production in Rufus Giwa Polytechnic Bakery, Owo, Ondo State,Nigeria, using linear programming technique. Three types of bread produced by the bakery were considered in the research and which are medium bread (X1), large bread (X2) and extra-large bread (X3) respectively. Data were collected for four (4) weeks based on temperature per unit of production of the breads using a pocket infrared thermometer so as to know if there will be any deviation in the mode of operation but everything proved to be the same since the process follows a repetitive process of production. According to authors Waheed et al (2012) linear programming models are frequently used in operation research and management sciences to solve specific problems concerning the use of scare resources. They demonstrated the application of linear programming in profit maximization in a product-mix company, in selecting the best means for selling her medicated soap product which include 1 tablet per pack, 3 tablets per pack, 12 tablets per pack and 120 tablets per pack, which are subject to some constraints. The data analysis was carried out with R- statistical package, the result of the analysis showed that the company would obtain optimal monthly profit level of about N271,296 if she concentrates mainly on the unit sales (one tablet per pack)of her medicated soap product ignoring other types of sales packages.

In the present paper, the linear programming model is used to the production of Mathri and Namkeen for the maximum profit.

II. General Form of a Linear Programming Model

The general Linear Programming model with n decision variables and m constraints can be stated in the following form.

$$\begin{aligned}
&\textit{Optimize}\ (\textit{Maximize or Minimize})\\
&Z = P_1x_1 + P_2x_2 + P_3x_3 + \dots\dots\dots + P_nx_n \quad (\textit{Objective Function})\\
&\textit{Subject to}
\end{aligned}$$

$$\left.\begin{array}{l}
r_{11}x_1 + r_{12}x_2 + r_{13}x_3 + \dots\dots\dots + r_{1n}x_n \ (\geq,=,\leq)\ q_1\\
r_{21}x_1 + r_{22}x_2 + r_{23}x_3 + \dots\dots\dots + r_{2n}x_n \ (\geq,=,\leq)\ q_2\\
r_{31}x_1 + r_{32}x_2 + r_{33}x_3 + \dots\dots\dots + r_{3n}x_n \ (\geq,=,\leq)\ q_3\\
\quad \vdots \qquad \vdots \qquad \vdots \qquad\qquad\qquad \vdots \qquad \vdots \qquad \vdots\\
r_{m1}x_1 + r_{m2}x_2 + r_{m3}x_3 + \dots\dots\dots + r_{mn}x_n \ (\geq,=,\leq)\ q_m
\end{array}\right\}\ \text{Constraints}$$

The above Model Can also be express in a compact form as follows.

$$\textit{Optimize}\ (\textit{Maximize or Minimize})$$

$$Z = \sum_{j=1}^{n} r_{ij}x_j \quad (\textit{Objective Function})$$

Subject to the Linear Constraints

$$\sum_{j=1}^{n} r_{ij}x_j \ (\geq,=,\leq)\ q_i\ , i = 1,2,3,\dots\dots, m \quad \textit{and}$$

$$x_j \geq 0\,,\ j = 1,2,3,\dots\dots, n \quad (\textit{Non-negativity condition})$$

Where $p_1, p_2, p_3, \dots\dots, p_n$ represent the per unit cost (or profit) of decision variables $x_1, x_2, x_3, \dots\dots, x_n$ to the value of the objective function. And $r_{11}, r_{12}, r_{13}, \dots\dots\dots, r_{2n}, \dots\dots\dots r_{m1}, r_{m2}, \dots\dots\dots, r_{mn}$ represent the resource of amount consumed per unit of the decision variables. The q_i represents the total availability of the i^{th} resource. Z
represent the measure of performance which can be either cost, or profit or reverence etc.

III. Standard Form of aLinear Programming Model

The use of the simplex method to solve a linear programming problem requires that the problem be converted into its standard form. The standard form of a linear programming problem has the following properties.

i. All the constraints should be expressed as equations by adding slack or surplus variables.

ii. The right-hand side of each constraint should be made of non-negative (if not). This is done by multiplying both sides of the resulting constraints by -1.

iii. The objective function should be of a maximization type.

For n decision variables and m constraints, the standard form of the linear programming model can be formulated as follows.

$$Optimize\ (Maximize)$$

$$Z = P_1x_1 + P_2x_2 + P_3x_3 + ... + P_nx_n + 0S_1 + 0S_2 + 0S_3 + ... + +0S_m$$

$$Subject\ to\ the\ Linear\ \text{Constraints}$$

$$r_{11}x_1 + r_{12}x_2 + r_{13}x_3 + ... + r_{1n}x_n = q_1$$

$$r_{21}x_1 + r_{22}x_2 + r_{23}x_3 + ... + r_{2n}x_n = q_2$$

$$r_{31}x_1 + r_{32}x_2 + r_{33}x_3 + ... + r_{3n}x_n = q_3$$

$$\begin{array}{cccc} \vdots & \vdots & \vdots & \vdots \\ \vdots & \vdots & \vdots & \vdots \\ \vdots & \vdots & \vdots & \vdots \end{array}$$

$$r_{m1}x_1 + r_{m2}x_2 + r_{m3}x_3 + ... + r_{mn}x_n = q_m$$

$$x_1, x_2, x_3, ..., x_n\ , s_1, s_2, s_3, ... s_m \geq 0$$

This Model can be stated in a more compact form as follows:

$$Optimize(Maximize\ or Minimize)$$

$$Z = \sum_{j=1}^{n} r_{ij}x_j + \sum_{i=1}^{m} 0x_i$$

Subject to the Linear Constraints

$$\sum_{j=1}^{n} r_{ij}x_j = q_i\ , i = 1,2,3,........., m\ \ and$$

$$x_j, s_i \geq 0\ (\ for\ all\ i\ and\ j\ )$$

Assumptions

- It is assumed that the Ingredients present for the production of Mathri and Namkeen are rare.
- It is assumed that an efficient allocation of Ingredients to the variables Mathri and Namkeen will aid optimal production and at the same time maximizing the profit of the small-scale industries.
- It is assumed that the qualities of Ingredients used in Mathri and Namkeen production are standard.

Presentation Data and Analysis

The data for this investigation purpose was composed of Vaishno bakery & sweets And Soni Kirana Store, Misrod Bhopal. The data insist of whole amount of Ingredients (All Purpose flour(maida),Besan ,Red chili powder , Ghee or oil, salt, ajwain (carom seeds) ,black pepper (Sabut kali Mirch), Kasuri methi (Dry fenugreek leaves) , Cumin seeds (jeera) ,Asafoetida (Hing) for test and Baking soda (for khasta) available for daily production of three different sizes of Mathri and Namkeen and profit contribution per each unit size of Mathri and Namkeen produced. The data analysis was carried out with LINGO software (version 18.0) and NCSS (version 12.0.9). The content of each Ingredient each unit product of Mathri and Nankeen Produced is shown below.

IV. Product Mathri

All Purpose Flour (Maida)

The absolute amount of flour present = 300kg

Each unit of Large packet Mathri needed 0.39kg of flour

Each unit of Medium packet Mathri needed 0.20kg of flour

Each unit of Small packet Mathri needed 0.04kg of flour

Total amount (volume) of Ghee or soybean Oil

The absolute amount of Ghee or soybean Oil present = 10L

Each unit of Large packet Mathri needed 0.028L of Ghee

Each unit of Medium packet Mathri needed 0.014L of Ghee

Each unit of Small packet Mathri needed 0.0028L of Ghee

Ajwain

The absolute amount of Ajwain present = 800g

Each unit of Large packet Mathri needed 0.00625g of Ajwain

Each unit of Medium packet Mathri needed 0.00313g of Ajwain

Each unit of Small packet Mathri needed 0.00063g of Ajwain

Black pepper (Sabut kali Mirch)

The Total amount of black pepper present = 600g

Each unit of Large packet Mathri needed 0.00625g of black pepper

Each unit of Medium packet Mathri needed 0.00313g of black pepper

Each unit of Small packet Mathri needed 0.00063g of black pepper

Kasuri methi or dry fenugreek leaves

The Total amount of Kasuri methi present = 900g

Each unit of Large packet Mathri needed 0.00625g of Kasuri methi

Each unit of Medium packet Mathri needed 0.00313g of Kasuri methi

Each unit of Small packet Mathri needed 0.000630g of Kasuri methi

Jeera (Cumin seeds)

The Total amount of Jeera present = 400g

Each unit of Large packet Mathri needed 0.00313g of Jeera

Each unit of Medium packet Mathri needed 0.00156g of Jeera

Each unit of Small packet Mathri needed 0.00032g of Jeera

1pinch ASafoetida (Hing)

The Total amount of Hing present = 20g

Each unit of Large packet Mathri needed 0.00019g of Hing

Each unit of Medium packet Mathri needed 0.00009g of Hing

Each unit of Small packet Mathri needed 0.00002g of Hing

1pinch Baking soda

The Total amount of baking soda present = 30g

Each unit of Large packet Mathri needed 0.00019g of baking soda

Each unit of Medium packet Mathri needed 0.00009g of baking soda

Each unit of Small packet Mathri needed 0.00002g of baking soda

Salt

The Total amount of salt present = 500g

Each unit of Large packet Mathri needed 0.0625g of salt

Each unit of Medium packet Mathri needed 0.03125g of salt

Each unit of Small packet Mathri needed 0.00625g of salt

Profit contribution per unit product (size) of Mathri produced

Each unit of Large packet Mathri = Rs97

Each unit of Medium packet Mathri = Rs58

Each unit of Small packet Mathri = Rs40

The above data can be abstract in a tabularize figure.

Ingredients	Product			Total Present Ingredients
	Large packet Mathri	Medium packet Mathri	Small packet Mathri	
All Purpose Flour(Maida) (kg)	0.39	0.20	0.04	300
Ghee or soybean (L)	0.028	0.014	0.0028	10
Ajwain(g)	0.00625	0.00313	0.00063	800
Black peeper(g)	0.00625	0.00313	0.00063	600
Kasuri Methi(g)	0.00625	0.00313	0.00063	900
Jeera (Cumin seeds)	0.00313	0.00156	0.00032	400
ASafoetida (Hing)	0.00019	0.00009	0.00002	20
Baking soda(g)	0.00019	0.00009	0.00002	30
Salt(g)	0.0625	0.03125	0.00625	500
Profit(Rs)	97	58	40	

Model formulation

Let the amount of Large packet Mathri to be manufacture = x_1

Let the amount of Medium packet Mathri to be manufacture = x_2

Let the amount of Small packet Mathri to be manufacture = x_3

Let Z mean the profit to be increased

The L.P model for the above composition data is stated by

$$MAX \quad Z = 97x_1 + 58x_2 + 40x_3$$
$$Subject\ to$$
$$0.39x_1 + 0.20x_2 + 0.04x_3 \leq 300$$
$$0.028x_1 + 0.014x_2 + 0.0028x_3 \leq 10$$
$$0.00625x_1 + 0.00313x_2 + 0.00063x_3 \leq 800$$
$$0.00625x_1 + 0.00313x_2 + 0.00063x_3 \leq 600$$
$$0.00625x_1 + 0.00313x_2 + 0.00063x_3 \leq 900$$
$$0.00313x_1 + 0.00156x_2 + 0.00032x_3 \leq 400$$
$$0.00019x_1 + 0.00009x_2 + 0.00002x_3 \leq 20$$
$$0.00019x_1 + 0.00009x_2 + 0.00002x_3 \leq 30$$
$$0.0625x_1 + 0.03125x_2 + 0.00625x_3 \leq 500$$
$$x_1, x_2, x_3 \geq 0.$$

Introducing slack Variables and the problem can be expressed in the following standard form ;

$$MAX \quad Z = 97x_1 + 58x_2 + 40x_3 + 0s_1 + 0s_2 + 0s_3 + 0s_4 + 0s_5 + 0s_6 + 0s_7 + 0s_8 + 0s_9$$
$$Subject\ to$$
$$0.39x_1 + 0.20x_2 + 0.04x_3 + s_1 = 300$$
$$0.028x_1 + 0.014x_2 + 0.0028x_3 + s_2 = 10$$
$$0.00625x_1 + 0.00313x_2 + 0.00063x_3 + s_3 = 800$$
$$0.00625x_1 + 0.00313x_2 + 0.00063x_3 + s_4 = 600$$
$$0.00625x_1 + 0.00313x_2 + 0.00063x_3 + s_5 = 900$$
$$0.00313x_1 + 0.00156x_2 + 0.00032x_3 + s_6 = 400$$
$$0.00019x_1 + 0.00009x_2 + 0.00002x_3 + s_7 = 20$$
$$0.00019x_1 + 0.00009x_2 + 0.00002x_3 + s_8 = 30$$
$$0.0625x_1 + 0.03125x_2 + 0.00625x_3 + s_9 = 500$$
$$x_1, x_2, x_3, s_1, s_2, s_3, s_4, s_5, s_6, s_7, s_8, s_9 \geq 0.$$

The above linear programming model was solved using LINGO software and NCSS (version 12.0.9), which gives an optimal solution of: x_1 = 0, x_2 = 0, x_3 = 3571.

Z = 142857.

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Interpretation of Result

Based on the data collected the optimum result derived from the model indicates that a Small packet of Mathri should be produced, small packet Mathri. Their production quantities should be 3571 units respectively. This will produce a maximum profit of Rs142857.

V. Product Namkeen

All Flour Besan

The absolute amount of Besan present = 500kg

Each unit of Large packet Namkeen needed 0.63kg of flour Besan

Each unit of Medium packet Namkeen needed 0.313kg of flour Besan

Each unit of Small packet Namkeen needed 0.063kg of flour Besan

The soybean Oil

Total amount (volume) soybean Oil present =50L

Each unit of Large packet Namkeen needed 0.63L of Soybean Oil

Each unit of Medium packet Namkeen needed 0.313L of Soybean Oil

Each unit of Small packet Namkeen needed 0.063L of Soybean Oil

Salt

The Total amount of salt present = 900g

Each unit of Large packet Namkeen needed 0.125g of salt

Each unit of Medium packet Namkeen needed 0.063g of salt

Each unit of Small packet Namkeen needed 0.013g of salt

Jeera (Cumin seeds)

The Total amount of Jeera present = 100g

Each unit of Large packet Namkeen needed 0.0125g of Jeera

Each unit of Medium packet Namkeen needed 0.0063g of Jeera

Each unit of Small packet Namkeen needed 0.0013g of Jeera

Ajwain

The absolute amount of Ajwain present = 200g

Each unit of Large packet Namkeen needed 0.025g of Ajwain

Each unit of Medium packet Namkeen needed 0.0125g of Ajwain

Each unit of Small packet Namkeen needed 0.0025g of Ajwain

1pinch ASafoetida (Hing)

The Total amount of Hing present = 20g

Each unit of Large packet Namkeen needed 0.00125g of Hing

Each unit of Medium packet Namkeen eeded 0.00063g of Hing

Each unit of Small packet Namkeen needed 0.00013g of Hing

Red Chili Powder

The Total amount of Red Chili Powder present = 500g

Each unit of Large packet Namkeen needed 0.40g of Red Chili Powder

Each unit of Medium packet Namkeen needed 0.20g of Red Chili Powder

Each unit of Small packet Namkeen needed 0.10g of Red Chili Powder

Profit contribution per unit product (size) of Namkeen produced

Each unit of Large packet Namkeen = Rs80

Each unit of Medium packet Namkeen = Rs35

Each unit of Small packet Namkeen = Rs16

The above data can be abstract in a tabularize figure.

Ingredients	Product			Total Present Ingredients
	Large packet Namkeen	Medium packet Namkeen	Small packet Namkeen	
Besan (kg)	0.63	0.313	O.O63	500
Soybean (L)	0.63	0.0313	0.063	50
Salt(g)	0.125	0.063	0.013	900
Jeera(g)	0.0125	0.0063	0.0013	100
Ajwain(g)	0.025	0.0125	0.0025	200
ASafoetida (Hing)	0.00125	0.00063	0.00013	20
Red Chili Powder	0.03125	0.01563	0.00313	500
Profit(Rs)	80	35	16	

Model formulation

Let the amount of Large packet Namkeen to be manufacture = x_1

Let the amount of Medium packet Namkeen to be manufacture = x_2

Let the amount of Small packet Namkeen o be manufacture = x_3

Let Z mean the profit to be increased

The LP model for the above composition data is stated by

$$
\begin{aligned}
&MAX \quad Z = 80x_1 + 35x_2 + 16x_3 \\
&Subject\ to \\
&0.63x_1 + 0.313x_2 + 0.063x_3 \leq 500 \\
&0.63x_1 + 0.313x_2 + 0.063x_3 \leq 50 \\
&0.125x_1 + 0.063x_2 + 0.013x_3 \leq 900 \\
&0.0125x_1 + 0.0063x_2 + 0.0013x_3 \leq 100 \\
&0.025x_1 + 0.0125x_2 + 0.0025x_3 \leq 200 \\
&0.00125x_1 + 0.00063x_2 + 0.00013x_3 \leq 20 \\
&0.03125x_1 + 0.01563x_2 + 0.00313x_3 \leq 500 \\
&x_1, x_2, x_3 \geq 0.
\end{aligned}
$$

Introducing slack Variables and the problem can be expressed in the following standard form ;

$$
\begin{aligned}
&MAX \quad Z = 80x_1 + 35x_2 + 16x_3 + 0s_1 + 0s_2 + 0s_3 + 0s_4 + 0s_5 + 0s_6 + 0s_7 \\
&Subject\ to \\
&0.63x_1 + 0.313x_2 + 0.63x_3 + s_1 = 500 \\
&0.63x_1 + 0.313x_2 + 0.063x_3 + s_2 = 50 \\
&0.125x_1 + 0.063x_2 + 0.013x_3 + s_3 = 900 \\
&0.0125x_1 + 0.0063x_2 + 0.0013x_3 + s_4 = 100 \\
&0.025x_1 + 0.0125x_2 + 0.0025x_3 + s_5 = 200 \\
&0.00125x_1 + 0.00063x_2 + 0.00013x_3 + s_6 = 20 \\
&0.03125x_1 + 0.01563x_2 + 0.00313x_3 + s_7 = 500 \\
&x_1, x_2, x_3, s_1, s_2, s_3, s_4, s_5, s_6, s_7 \geq 0.
\end{aligned}
$$

The above linear programming model was solved using LINGO software and NCSS, which gives an optimal solution of: $x_1 = 0$, $x_2 = 0$, $x_3 = 794$

Z = 12698.

Interpretation of Result

Based on the data collected the optimum result derived from the model indicates that one type of packet Namkeen should be produced, Small packet. Their production quantities should be 794 units respectively. This will produce a maximum profit of Rs12698.

VI. Summary

The goal of this investigation work was to apply L.P (linear programming) for optimal use of Ingredients in MATHRI AND NAMKEEN production. Vaishno bakery & sweets and Soni Kirana Store was used as our case study. The decision variables in this research work are the three different packing sizes of Mathri and Namkeen produced by Vaishno bakery & sweets and Soni Kirana Store. The researcher focused mainly on twelve Ingredients (All purples flour, Besan, Ghee, Soybean Oil, Red Chili Powder, Ajwain, black peeper, Kasuri methi, hing, salt, Jeera , and baking soda)used in the production and the amount of Ingredients needed of each variable (Mathri and Namkeen). The result shows that 3571 unit of small Mathri and 794 unit of Small Nakmeen should be produce respectively which will give a maximum profit of Rs142857 of Mathri and Rs 12698 of Namkeen .

VII. Conclusion

In light of the examination did in this investigation work and the outcome appeared, Vaishno bakery & sweets and Soni Kirana Store should create the three sizes Mathri and Namkeen with the end goal to fulfill clients. Additionally, a greater amount of Small packet of Mathri and the small packet of Namkeen ought to be created with the end goal to achieve most extreme benefit, since they contribute for the most part to the benefit earned by the Small Scale Industries.

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