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Optimizing Junior Fried Chicken Business Production Profits Using the Fuzzy Linear Programming Method

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ABSTRACT

This research aims to optimize production and profits in the Junior Fried Chicken business using the Fuzzy Linear Programming (FLP) method. The data collected includes product data, raw materials, production costs, and sales profits. The author constructs a mathematical model that includes objective functions and constraints based on the data obtained. Next, the Fuzzy Linear Programming (FLP) method is used to make optimal decisions about the amount of production for each menu. It is hoped that the results of this research can help business owners optimize their production and profits.

Keyword: production profits, production optimization, Fuzzy Linear Programming

1. INTRODUCTION

In the business world, optimizing production and profits is a key factor for the success of a business. In the food industry, such as restaurants or food stalls, it is important for business owners to organize production well to meet customer demand and maximize profits. In this context, this research focuses on the Junior collected through interviews with business owners. The data collected includes information about the product menu Fried Chicken business. This research methodology consists of several steps. First, the data required for this research was, raw materials used, availability of raw materials, production costs, selling prices and sales profits. After the data is collected, the next step is data processing using the Fuzzy Linear Programming method. This method is used to solve production optimization problems by considering existing constraints, such as the availability of raw materials and the desired production amount.

Next, the author compiled a mathematical model in the form of an objective function and constraints based on the data obtained. The objective function in this research is to maximize production profits, while the constraints include the availability of raw materials, production quantities, etc. The decisions making method used in this research is Fuzzy Linear Programming to solve production optimization problems [4]. The results of completing the mathematical model using this method are then processed further using a fuzzification and defuzzification process to produce optimal decisions regarding the production quantities for each menu. With the results of this research, it is hoped that Junior Fried Chicken business owners can have better guidance in managing their production to maximize profits. Apart from that, the Fuzzy Linear Programming method used in this research can also be an effective alternative in decision making in the business sector.

2. METHODS

2.1 Data Collection

The data collected and used in this research includes data on fried chicken products, product raw materials, availability of raw materials, production costs and sales profits. These data were obtained through interviews with business owners.

2.2 Data Processing

The data obtained was then processed using the Fuzzy Linear Programming method with the help of LINDO software to solve production optimization problems.

2.3 Methods for Preparing Mathematical Models

The author constructs a mathematical model in the form of an objective function and constraints based on the data obtained. The objective function is to maximize production profits, while the constraints include the availability of raw materials, production quantities, etc.

3. RESULT AND DISCUSSIONS

In this study the authors took data from the Junior Fried Chicken business located on Jalan Pembangunan. The data taken in the form of a menu consisting of Chicken, Rice, Tea, Chicken + Rice, Chicken + Rice + Tea. The raw materials of each product are in the following table.

Table 1. Raw materials of fried chicken products

No.	Raw Materials	Product Type				
		Chicken	Rice	Tea	Chicken+Rice	Chicken+Rice+Tea
1	Chicken	57gr	-	-	57 gr	57 gr
2	Flour	83 gr	-	-	83 gr	83 gr
3	Rice	-	100 gr	-	100 gr	100 gr

4	Tea Powder	-	-	5 gr	-	5 gr
5	Water	166 gr	150 gr	100 gr	316 gr	416 gr
6	Sugar	-	-	9 gr	-	9 gr
7	Oil	150 gr	-	-	150 gr	150 gr

The author took data for 14 days of sales. The number of fried chicken product sales in 14 days consisted of 140 Chicken, 126 Rice, 140 teas, 182 Chicken + Rice, and 196 Chicken + Rice + Tea. Production data in this study includes product types, production costs, selling prices for each menu, and production profits for each menu. Production data is presented in the following table.

Table 2. Fried chicken production data

No.	Product Type	Production Cost	Selling Price	Advantages
1	Chicken	7.100 IDR	8.000 IDR	900 IDR
2	Rice	1.500 IDR	4.000 IDR	2.500 IDR
3	Tea	1000 IDR	4.000 IDR	3.000 IDR
4	Chicken+Rice	8.700 IDR	15.000 IDR	6.300 IDR
5	Chicken+Rice+Tea	9.600 IDR	13.000 IDR	3.400 IDR

3.1 Developing a Mathematical Model

There are five variables in this study, namely x_1 as Chicken, x_2 as Rice, x_3 as Tea, x_4 as Chicken+Rice, and x_5 as Chicken+Rice+Tea. The objective of this study is to maximize production profit by maximizing the quantity of products produced. The objective and constraint functions in this study are as follows.

Maximize:

$$Z = 900x_1 + 2500x_2 + 3000x_3 + 6300x_4 + 3400x_5$$

Subject to: (1)

$$57x_1 + 57x_4 + 57x_5 \leq 30000$$

$$83x_1 + 83x_4 + 83x_5 \leq 44000$$

$$100x_2 + 100x_4 + 100x_5 \leq 51000$$

$$5x_3 + 5x_5 \leq 2000$$

$$166x_1 + 150x_2 + 100x_3 + 316x_4 + 416x_5 \leq 196000$$

$$9x_3 + 9x_5 \leq 4000$$

$$150x_1 + 150x_4 + 150x_5 \leq 79000$$

$$x_1 \geq 140$$

$$x_2 \geq 126$$

$$x_3 \geq 140$$

$$x_4 \geq 182$$

$$x_5 \geq 196$$

3.2 Fuzzification Process

Companies will think of several things in finding raw materials for manufacturing, including quality, price, needs and most importantly availability. Raw materials must be available in sufficient quantities and easily accessible. Good availability ensures smooth production without too much interruption due to raw material limitations. The company's reserve in raw material availability is 10% of the available amount, so the above problem can be written as follows.

Maximize:

$$Z = 900x_1 + 2500x_2 + 3000x_3 + 6300x_4 + 3400x_5$$

Subject to: (2)

$$57x_1 + 57x_4 + 57x_5 \leq 30000 + 3000t$$

$$83x_1 + 83x_4 + 83x_5 \leq 44000 + 4400t$$

$$100x_2 + 100x_4 + 100x_5 \leq 51000 + 5100t$$

$$5x_3 + 5x_5 \leq 2000 + 200t$$

$$166x_1 + 150x_2 + 100x_3 + 316x_4 + 416x_5 \leq 196000 + 19600t$$

$$9x_3 + 9x_5 \leq 4000 + 400t$$

$$150x_1 + 150x_4 + 150x_5 \leq 79000 + 7900t$$

$$x_1 \geq 140$$

$$x_2 \geq 126$$

$$x_3 \geq 140$$

$$x_4 \geq 182$$

$$x_5 \geq 196$$

Furthermore, the fuzzy linear programming method will be used to calculate the results of the constraints that have been determined, namely by calculating t = 0 and t = 1. When t = 0 means that all constraint functions do not use interval tolerance value limits so that the equation becomes

Maximize:

$$Z = 900x_1 + 2500x_2 + 3000x_3 + 6300x_4 + 3400x_5$$

Subject to: (3)

$$57x_1 + 57x_4 + 57x_5 \leq 30000$$

$$83x_1 + 83x_4 + 83x_5 \leq 44000$$

$$100x_2 + 100x_4 + 100x_5 \leq 51000$$

$$5x_3 + 5x_5 \leq 2000$$

$$166x_1 + 150x_2 + 100x_3 + 316x_4 + 416x_5 \leq 196000$$

$$9x_3 + 9x_5 \leq 4000$$

$$150x_1 + 150x_4 + 150x_5 \leq 79000$$

$$x_1 \geq 140$$

$$x_2 \geq 126$$

$$x_3 \geq 140$$

$$x_4 \geq 182$$

$$x_5 \geq 196$$

Furthermore, the calculation will be carried out continuously until a non-negative Z value is obtained. In simplifying the calculation process in the simplex table, the Lindo software can be used, obtained 7 iterations with x_1 = 140, x_2 = 126, x_3 = 140, x_4 = 182 and x_5 = 196 with the value of the objective function Z_l = 2698360.

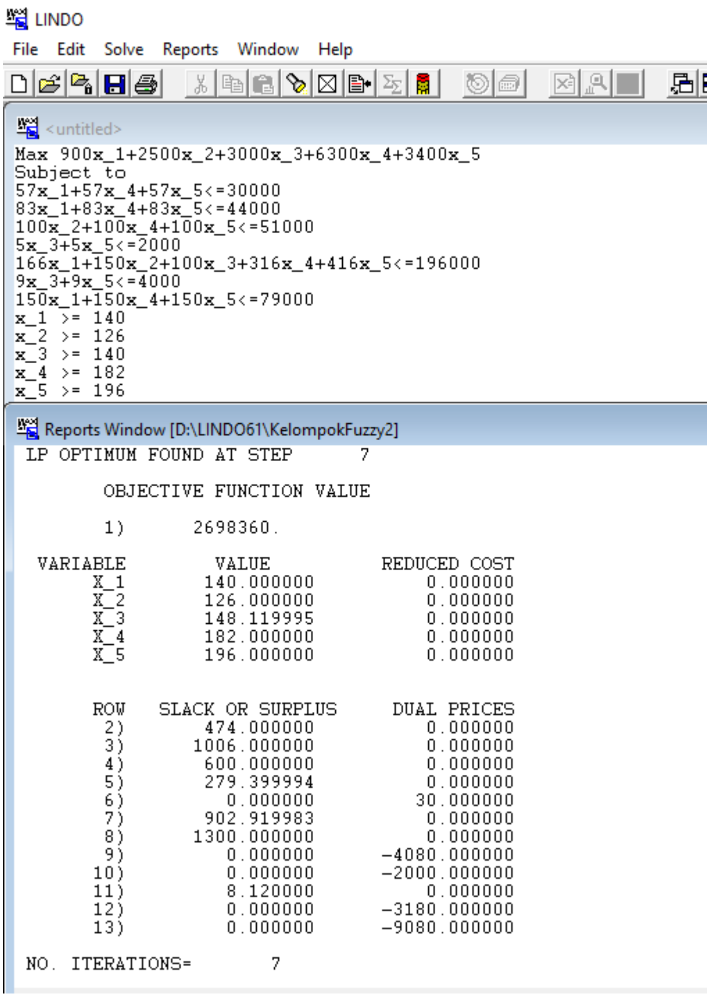


Figure1. Fuzzification t = 0

When t = 1 means that all constraint functions are formed using interval tolerance value constraints, so the equation becomes

Maximize:

$$Z = 900x_1 + 2500x_2 + 3000x_3 + 6300x_4 + 3400x_5$$

Subject to: (4)

$$57x_1 + 57x_4 + 57x_5 \leq 33000$$

$$83x_1 + 83x_4 + 83x_5 \leq 48400$$

$$100x_2 + 100x_4 + 100x_5 \leq 56100$$

$$5x_3 + 5x_5 \leq 2200$$

$$166x_1 + 150x_2 + 100x_3 + 316x_4 + 416x_5 \leq 215600$$

$$9x_3 + 9x_5 \leq 4400$$

$$150x_1 + 150x_4 + 150x_5 \leq 86900$$

$$x_1 \geq 140$$

$$x_2 \geq 126$$

$$x_3 \geq 140$$

$$x_4 \geq 182$$

$$x_5 \geq 196$$

In simplifying the calculation process in the simplex table, the Lindo software can be used, obtained 1 iteration with $x_1 = 140$, $x_2 = 126$, $x_3 = 244$, $x_4 = 214$, and $x_5 = 196$ with the value of the objective function Z_u = 3185606.

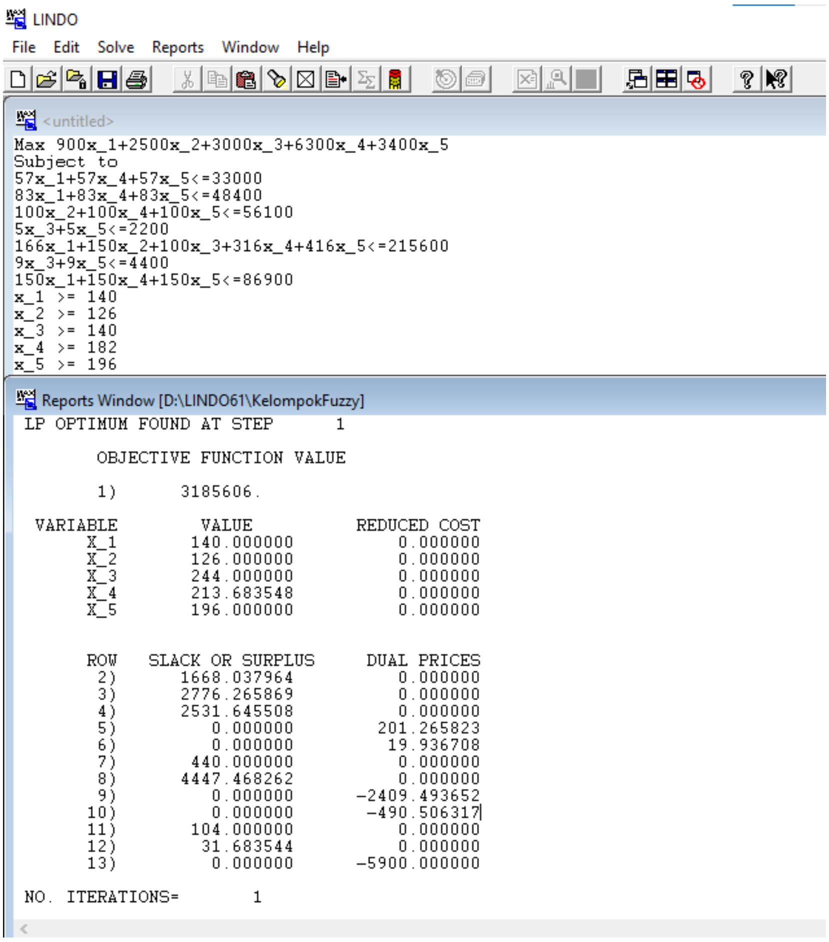


Figure 2. Fuzzification t = 1

3.3 Defuzzification Process

Next, determine the fuzzy value by creating a new constraint, namely the derivative of the objective function by adding the value of t = 0 and t = 1. In the calculation, λ of t = 0 and t = 1.

$$p_0 = Z_u - Z_L \tag{5}$$

$$p_0 = 3185606 - 2698360 = 487246$$

In calculating the value $\lambda - cut$ and taking the value of $\lambda = 1 - t$ a fuzzy linear program model will be formed as follows:

$$487246\lambda - (900x_1 + 2500x_2 + 3000x_3 + 6300x_4 + 3400x_5) \tag{6}$$

$$3000\lambda + 57x_1 + 57x_4 + 57x_5 \leq 33000$$

$$4400\lambda + 83x_1 + 83x_4 + 83x_5 \leq 48400$$

$$5100\lambda + 100x_2 + 100x_4 + 100x_5 \leq 56100$$

$$200\lambda + 5x_3 + 5x_5 \leq 2200$$

$$19600\lambda + 166x_1 + 150x_2 + 100x_3 + 316x_4 + 416x_5 \leq 215600$$

$$400\lambda + 9x_3 + 9x_5 \leq 4400$$

$$7900\lambda + 150x_1 + 150x_4 + 150x_5 \leq 86900$$

$$x_1 \geq 140$$

$$x_2 \geq 126$$

$$x_3 \geq 140$$

$$x_4 \geq 182$$

$$x_5 \geq 196$$

So that a linear program will be formed as follows:

$$-487246\lambda + 900x_1 + 2500x_2 + 3000x_3 + 6300x_4 + 3400x_5 \tag{7}$$

$$3000\lambda + 57x_1 + 57x_4 + 57x_5 \leq 33000$$

$$4400\lambda + 83x_1 + 83x_4 + 83x_5 \leq 48400$$

$$5100\lambda + 100x_2 + 100x_4 + 100x_5 \leq 56100$$

$$200\lambda + 5x_3 + 5x_5 \leq 2200$$

$$19600\lambda + 166x_1 + 150x_2 + 100x_3 + 316x_4 + 416x_5 \leq 215600$$

$$400\lambda + 9x_3 + 9x_5 \leq 4400$$

$$7900\lambda + 150x_1 + 150x_4 + 150x_5 \leq 86900$$

$$x_1 \geq 140$$

$$x_2 \geq 126$$

$$x_3 \geq 140$$

$$x_4 \geq 182$$

$$x_5 \geq 196$$

The equation can be solved with the help of Lindo software as shown in Figure 3, the optimum result of the Mathematical equation above is A (in LINDO software to replace λ) that is λ = 0,5, x_1 = 140, x_2 = 126, x_3 = 223, x_4 = 187, danx_5 = 196. using fuzzy linear programming obtained 140 chicken menus, 126 rice menus, 237 tea menus, 182 chicken + rice menus, and 196 chicken + rice + tea menus.

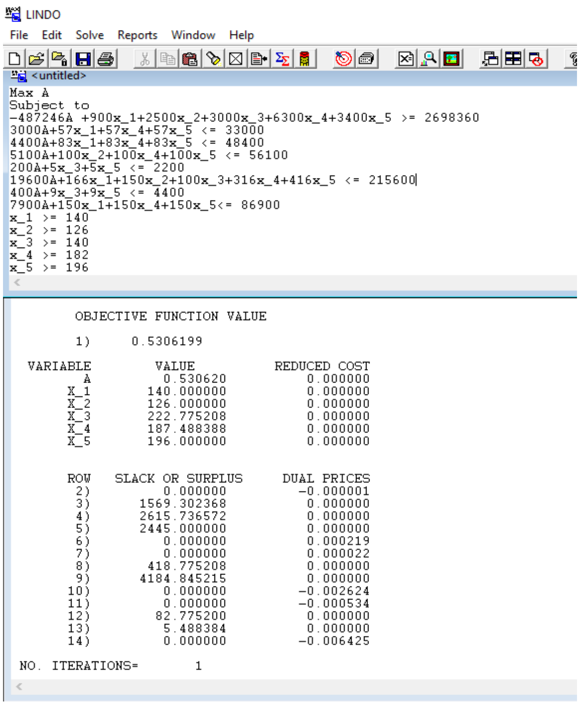


Figure3. Defuzzification with new constraints λ

Therefore, to calculate the required raw material constraints are

1. Chicken = 57(140) + 57(187) + 57(196) = **29811 gram**
2. Flour = 83(140) + 83(187) + 83(196) = **43409 gram**
3. Rice = 100(126) + 100(187) + 100(196) = **50900 gram**
4. Tea powder = 5(223) + 5(196) = **2095 gram**
5. Water = 166(140) + 150(126) + 100(223) + 316(187) + 416(196) = **205068 gram**
6. Sugar = 9(223) + 9(196) = **3711 gram**
7. Oil = 150(140) + 150(187) + 150(196) = **78450 gram**

The membership value of each constraint is:

1. Constraint 1: μ_1 $[B_1X]$ = 1 because (29811 < 30000)
2. Constraint 2: μ_2 $[B_2X]$ = 1 because (43409 < 44000)
3. Constraint 3: μ_3 $[B_3X]$ = 1 because (50900 < 51000)
4. Limitation 4: μ_4 $[B_4X]$ = $\frac{2200-2095}{200} = 0{,}5$
5. Limitation 5: μ_5 $[B_5X]$ = $\frac{215600-205068}{19600} = 0.{,}5$
6. Constraint 6: μ_6 $[B_6X]$ = 1 because (3711 < 4000)
7. Constraint 7: μ_3 $[B_3X]$ = 1 because (78450 < 79000)

The value λ = 0,5 is the membership value in the fuzzy set. The expected solution of fuzzy linear programming is a solution with a large membership value. The value of λ = 0,5 implies that $\lambda - cut$ for each set used to implement each constraint equal to 0,5. The scale used to determine the amount of the largest addition of each permitted constraint is t = 1 − 0,5 = 0,5. For example, for chicken, the permitted addition of raw materials is 33000 grams, the maximum addition required is only as much as 3000(0,5) = 1500 gram. The following table explains the maximum required addition.

Table 3. Maximum addition

No.	Type	Permissible addition (grams)	Max addition (gram)
1	Chicken	33.000	1.500
2	Flour	48.400	2.200
3	Rice	56.100	2.550
4	Tea Powder	2.200	100
5	Water	215.600	9.800
6	Sugar	4.400	200
7	Oil	86.900	3.950

After obtaining the results in fuzzy linear programming, it is known that the maximum addition of each constraint is equal to 0.5. Then a new constraint is formed according to the constraints obtained as follows

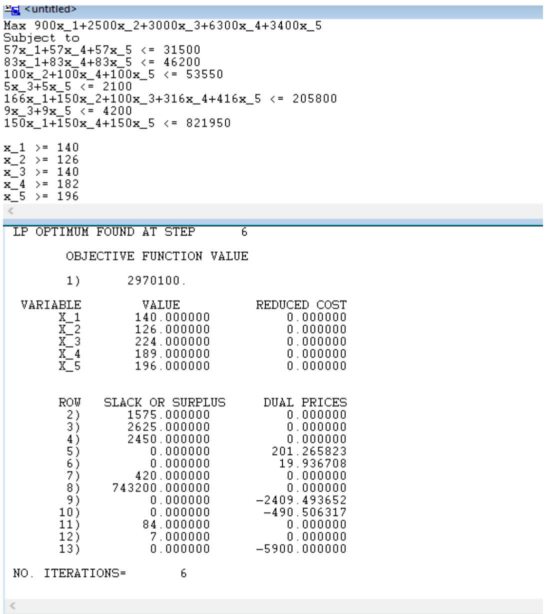
Maximize:

$$Z = 900x_1 + 2500x_2 + 3000x_3 + 6300x_4 + 3400x_5$$

Subject to: (8)

$$57x_1 + 57x_4 + 57x_5 \leq 31500$$
$$83x_1 + 83x_4 + 83x_5 \leq 46200$$
$$100x_2 + 100x_4 + 100x_5 \leq 53550$$
$$5x_3 + 5x_5 \leq 2100$$
$$166x_1 + 150x_2 + 100x_3 + 316x_4 + 416x_5 \leq 205800$$
$$9x_3 + 9x_5 \leq 4200$$
$$150x_1 + 150x_4 + 150x_5 \leq 821950$$
$$x_1 \geq 140$$
$$x_2 \geq 126$$
$$x_3 \geq 140$$
$$x_4 \geq 182$$
$$x_5 \geq 196$$

With the help of LINDO software, the optimum results are obtained, namely x_1= 140, x_2 = 126, x_3 = 224, x_4 = 189, dan x_5 = 196. with the value of Z = 2.970.100. By using the fuzzy linear programming method, we have obtained the optimum result. With the help of LINDO software, the optimum results obtained are integers.



```
<untitled>
Max 900x_1+2500x_2+3000x_3+6300x_4+3400x_5
Subject to
57x_1+57x_4+57x_5 <= 31500
83x_1+83x_4+83x_5 <= 46200
100x_2+100x_4+100x_5 <= 53550
5x_3+5x_5 <= 2100
166x_1+150x_2+100x_3+316x_4+416x_5 <= 205800
9x_3+9x_5 <= 4200
150x_1+150x_4+150x_5 <= 821950

x_1 >= 140
x_2 >= 126
x_3 >= 140
x_4 >= 182
x_5 >= 196

 LP OPTIMUM FOUND AT STEP      6

        OBJECTIVE FUNCTION VALUE

        1)      2970100.

  VARIABLE        VALUE          REDUCED COST
       X_1       140.000000          0.000000
       X_2       126.000000          0.000000
       X_3       224.000000          0.000000
       X_4       189.000000          0.000000
       X_5       196.000000          0.000000


       ROW   SLACK OR SURPLUS     DUAL PRICES
        2)      1575.000000          0.000000
        3)      2625.000000          0.000000
        4)      2450.000000          0.000000
        5)         0.000000        201.265823
        6)         0.000000         19.936708
        7)       420.000000          0.000000
        8)    743200.000000          0.000000
        9)         0.000000      -2409.493652
       10)         0.000000       -490.506317
       11)        84.000000          0.000000
       12)         7.000000          0.000000
       13)         0.000000      -5900.000000

 NO. ITERATIONS=       6
```

Figure4. Results

3.4 Analysis Result

A fuzzy linear programming model was implemented to optimize the profits of Junior Fried Chicken, considering uncertainties and tolerances in its parameters. The model comprises two main stages: fuzzification and defuzzification. The fuzzification stage aims to obtain the logic values $t = 0$ and $t = 1$. At $t = 0$, the constraint functions are formed without considering the tolerance interval limits, whereas at t=1, the tolerance interval limits are incorporated into the constraint functions. The second stage, defuzzification, involves constructing a new linear programming model to achieve a higher level of optimization. Based on the results processed using LINDO software, the application of fuzzy linear programming resulted in a profit of 2.970.100. The optimal production includes 140 portions of chicken menu, 126 portions of rice-only menu, 224 portions of tea, 189 portions of chicken with rice, and 196 portions of chicken with rice and tea. Compared to the previous profit of 2.674.000, the fuzzy linear programming method yielded an increase of 296.000, or an 11,0695% improvement. Therefore, it is evident that the Junior Fried Chicken business on Jl. Pembangunan has experienced a significant profit increase due to the application of this model.

4. CONCLUSION

Based on data processing and profit optimization analysis of menu sales at Junior Fried Chicken, Jl. Pembangunan, using LINDO software, the following conclusions were obtained:

a. Junior Fried Chicken, Jl. Pembangunan, increased raw material by 10% from the provided amount. The optimal production quantities after applying the fuzzy linear programming
b. Junior Fried Chicken, Jl. Pembangunan, initially had a profit of Rp2.674.000. After implementing the fuzzy linear programming method, the profit increased to Rp2.970.100 representing an 11,0695% increase in profit.

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