PAPER

Multiatribute decision-making: use of scoring methods to compare the performance of laying hen fed with different levels of yeast

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Abstract

A wide variety of comparative performance reports from use of different levels of dietary supplements in animal production can be helpful to decision makers. However, with the complexity and amount of information in these reports, decision making as to which dietary level of supplement is to be used is difficult. This problem is overcome only when all data can be put into a common unit. For this purpose, the present study examined our previously reported data on the effects of different levels of dietary Saccharomyces cerevisiae on performance and egg quality traits of laying hens. In this survey, five different scoring methods of maximin, equally likely, weighted average, ordered weighted averages and technique for order preference by similarity to ideal solution (TOPSIS) were used to choose the best level (0, 0.25, 0.5, 0.75 and 1 g kg⁻¹ diet) of dietary Saccharomyces cerevisiae. The methods of equally likely, weighted average, and ordered weighted averages showed the best result at 1 g kg⁻¹ diet of the dietary supplement but maximin and TOPSIS showed only 0.5 and 0.75 of dietary level, respectively. Overall, birds fed diet containing 0.75-1 g yeast per kg diet had better performance as compared to other groups.

Introduction

The aim of this study was to examine the use of subtherapeutic levels of antibiotics as growth promoters in poultry feed for enhanced performance and reduced morbidity in chickens. However, development of pathogen resistance and the potential effects on consumers has resulted in the development of non-antibiotic supplements, such as yeasts and yeast products, as alternatives to antibiotics that may improve poultry performance (Li et al., 2006; Yalcin et al., 2010). Our previous study showed that dietary levels of Saccharomyces cerevisiae (0, 0.25, 0.5, 0.75 and 1 g kg⁻¹ diet) differently affected the performance traits in laying hens (Hosseini et al., 2006). For example, at 59 to 78 weeks of age, dietary yeast at the levels of 0.75 and 1 g kg⁻¹ diet significantly increased egg mass compared to the control group. However, there was no significant difference in egg mass between treatments of 0.25, 0.5, 0.75 and 1 g of yeast per kg diet. Treatment of 1 g yeast significantly improved feed conversion ratio as compared to the control group at 59 to 78 weeks of age while no significant differences were seen among dietary yeast treatments. In addition, yeast supplementation does not have a significant effect on egg production and average egg weight at 59 to 78 weeks of age or over the full course of the experiment (25-78 weeks).

Based on these results, since in animal science research several attributes with different scales, direction, etc. are measured, making a decision on the basis of these results is an important problem. All attributes must be considered in order to make the most appropriate decision. One of the best methods is to use multiattribute decision-making. In the study by Hwang and Yoon (1981), a group of 17 multiattribute decision-making methods were classified according to the type and importance of the information received. Roush and Crawener (1992) compared four multicriteria decision analysis methods of maximin, equally likely averaging, weighted averaging and ordered weighted averaging to choose the best commercial laying hen strain. They found that in three of four weighted decision, the same strain of hen was chosen. Another method of multiattribute decision making is TOPSIS, which seems to have potential applications in many areas of poultry production, including choosing the best level of a dietary supplement, purchasing equipment or property, and assessing investment and genetic selection decisions.

To the best of our knowledge, no study has yet investigated multicriteria decision analysis methods in animal, and in particular poultry feed supplement. Therefore, the present study aimed to evaluate the five aforementioned multicriteria decision analysis methods to choose the best level of yeast in the diet according to the performance of laying hens reported in our previous study.

Materials and methods

Decision analysis

Decision analysis technique can be used for choosing among a set of alternatives. A well-behaved decision maker uses logic, and all available data and possible alternatives (i.e. multicriteria). Making decisions based on decision analysis techniques is not always easy. In fact, in some situations, a decision made according to the decision maker’s perception has a more desirable outcome than those of a decision maker who uses the most complicated of decision processes. However, in the long term, decision analysis will give more successful results than an impulsive approach (Roush and Crawener, 1992). In a decision analysis process, a decision is made by the following steps: i) determination of the production criteria to be considered in the decision; ii) selection of the other ways to evaluate these responses; iii) determination of the importance of each production criterion; iv) determination of how each strain performs; and v) detection of the best strain.

Multicriteria decision example

Table 1 shows 10 performance measures (criteria) of laying hens fed diet containing different levels of dietary yeast (0, 0.25, 0.5,
0.75 and 1 g kg⁻¹ diet) at 25-87 weeks of age (Hosseini et al., 2006). The following mathematical relationship relates performance criteria to the fuzzy concept of desirability:

\[ \mu_S = \frac{S_{\text{min}}}{\max(S) - S_{\text{min}}} \]

where:

\( \mu_S \) represents the desirability values of members of the fuzzy set S. Min(S) and max(S) are minimum and maximum values, respectively, in the fuzzy set S. For example, to express the fuzzy concept of the value of egg production for minimum and maximum values, respectively, in the fuzzy set S. For example, to express the fuzzy concept of desirability:

\[ \mu_{S_{\text{Egg production}}} = \frac{81.503}{83.479} = 0.352 \]

When all the values are calculated for the set S of egg production, the result is as follows:

\[ S_{\text{Egg production}} = \{0.352, 0.000, 0.379, 1.000, 0.882\} \]

These membership values, representing the desirability of egg production for each dietary yeast level, are shown in Table 2 together with membership values for all other criteria.

Of some of the criteria have a negative relationship to desirability, such as the feed conversion ratio. To represent this membership values in a positive manner, the complement of \( \mu_S \) was used:

\[ \mu_S^* = 1 - \frac{S_{\text{min}}}{\max(S) - S_{\text{min}}} \]

or

\[ \mu_S^* = 1 - \mu_S \]

The strategy for making the decision depends on the needs of the decision maker. Four alternative ways to evaluate production responses were examined: maximin, equally likely, weighted averaging, and ordered weighted averaging decision analysis.

The ideal point methods

In the ideal point method, the options are ordered according to their separation from an ideal point. The ideal point is defined as the most desirable, weighted, hypothetical option (decision outcome) and the closest option to the ideal point is the best one. One of the most popular ideal point techniques is the TOPSIS which was introduced by Hwang and Yoon (1981).

The ideal point method involves the following steps:

- determine the set of feasible alternatives;
- standardize each attribute map layer;
- define the weights assigned to each attribute (\( 0 \leq w \leq 1, \sum w = 1 \));
- construct the weighted standardized map layer by multiplying each value of the standardized layer by the corresponding weight;
- determine the maximum value for each of the weighted standardized map layers (the values determine the ideal point);
- determine the mean value for each weighted standardized map layer (the values determine a negative ideal point);
- using a separation measure, calculate the distance between the ideal point and each alternative;
- using the same separation measure, determine the distance between the negative ideal point and each alternative;
- measure the relative closeness to the ideal point;
- rank the alternatives on the basis of descending order of ideal point.

Complete ranking and information regarding the relative distance of each option to the ideal point is provided by the ideal point. In this method, an alternative is treated as an inseparable bundle of attributes, which makes the method an attractive approach when the dependency among attributes is difficult to test or verify (Malczewski, 1997).

### Results and discussion

Decision analysis is a method that can be used to choose among two or more alternatives. From a management point of view, a

### Table 1. Production criteria of laying hens fed diet supplemented with different levels of Saccharomyces cerevisae (g kg⁻¹ diet) at 25-78 weeks of age.

| Criteria                      | Positive or negative | 0 (A) | 0.25 (B) | 0.5 (C) | 0.75 (D) | 1 (E) |
|-------------------------------|----------------------|-------|----------|---------|----------|-------|
| Feed intake, g/day            | N                    | 98.504| 99.128   | 98.200  | 99.745   | 98.505|
| Egg production, %             | P                    | 81.653| 80.428   | 81.584  | 83.479   | 82.118|
| Average egg weight, g         | P                    | 58.027| 58.819   | 58.752  | 58.567   | 58.883|
| Egg mass, g                   | P                    | 47.003| 47.387   | 47.937  | 48.894   | 48.812|
| Feed conversion               | N                    | 2.095 | 2.095    | 2.010   | 2.010    | 2.000 |
| Feed cost per kg egg, Rial    | N                    | 4457.0| 4497.2   | 4436.1  | 4445.2   | 4439.4|
| Egg shell thickness           | P                    | 0.295 | 0.296    | 0.292   | 0.293    | 0.291 |
| Specific gravity              | P                    | 1.087 | 1.086    | 1.090   | 1.088    | 1.0859|
| Egg shell stretch             | P                    | 2.030 | 2.108    | 2.058   | 2.017    | 2.054 |
| Haugh unit                    | P                    | 94.43 | 91.22    | 90.767  | 90.145   | 94.322|

N: negative response; low level of response is of merit for decision maker; P: positive response; high level of response is of merit for decision maker; Rial, Iranian currency. Yeast supplementation: (A) 0 g kg⁻¹ diet; (B) 0.25 g kg⁻¹ diet; (C) 0.5 g kg⁻¹ diet; (D) 0.75 g kg⁻¹ diet; (E) 1 g kg⁻¹ diet.

### Table 2. Decision matrix based on fuzzy set membership values for the production criteria in Table 1.

| Criteria                      | 0 (A) | 0.25 (B) | 0.5 (C) | 0.75 (D) | 1 (E) |
|-------------------------------|-------|----------|---------|----------|-------|
| Feed intake, g/day            | 0.803 | 0.339    | 1.000   | 0.800    | 0.803 |
| Egg production, %             | 0.205 | 0.000    | 0.379   | 1.000    | 0.882 |
| Average egg weight, g         | 0.000 | 1.000    | 0.813   | 0.605    | 0.960 |
| Egg mass, g                   | 0.000 | 0.192    | 0.487   | 1.000    | 0.556 |
| Feed conversion               | 0.000 | 0.011    | 0.895   | 0.895    | 1.000 |
| Feed cost per kg egg, Rial    | 0.661 | 0.000    | 1.000   | 0.852    | 0.946 |
| Egg shell thickness           | 0.778 | 1.000    | 0.156   | 0.389    | 0.000 |
| Specific gravity              | 0.271 | 0.047    | 1.000   | 0.024    | 0.000 |
| Egg shell stretch             | 0.000 | 0.543    | 0.194   | 1.000    | 0.166 |
| Haugh unit                    | 1.000 | 0.251    | 0.145   | 0.000    | 0.975 |
| Decision                      | Maxmin | 0.000    | 0.000   | 0.000    | 0.000 |
| Equally likely                | 0.000 | 0.000    | 0.145   | 0.000    | 0.000 |

Yeast supplementation, (A) 0 g kg⁻¹ diet; (B) 0.25 g kg⁻¹ diet; (C) 0.5 g kg⁻¹ diet; (D) 0.75 g kg⁻¹ diet; (E) 1 g kg⁻¹ diet. Rial, Iranian currency.
good decision is based on logic and on consideration of all available data and possible alternatives (i.e. multicriteria). In the present study, five scoring methods of maximin, equally likely, weighted average, ordered weighted averages and TOPSIS were used in order to introduce the best level of yeast supplementation in accordance with the results obtained.

Maximin approach

Maximin is one of the decisions analyses that rare regularly used (Roush and Cravener, 1992). In this method, the maximum value of all minimum values is used; hence, its name Maximin. As shown in Table 2, the decision set (D) was based on the minimum values in each column.

\[ D = (0.00/(A), 0.00/(B), 0.145/(C), 0.00/(D) \text{ and } 0.00/(E)) \]

Dietary yeast levels ranking of the maximin method was as follows:

\[(C)> (A)= (B)= (D)= (E)\]

The 0.00/(A) indicates the membership value for dietary yeast level of 0 is 0.00, and so on. Since in this method decision making analysis is based on single production criteria, and overall performance is not considered, the maximin procedure is not appropriate. For example, those times that yeast level of 1 (E) had a full membership in the set were ignored. In fact, each dietary level contains at least one minimum value trait in the decision matrix.

Averaging or equally likely decision

Averaging allows each of the production responses to play a part in the decision process. In Tables 1 and 2, ten criteria for various performance traits of different dietary levels of yeast are listed. These values are very much subjective and could vary according to decision maker bias. In this method, the decision maker averages the values of performance criteria in each of the columns representing each level of supplementation (e.g. for group (A), \(0.803+0.352+...+1.000/10=0.205\)), and then the group that had the highest average value was chosen (Table 2). In this example, in comparison with other groups, group E has a higher yield. The ranking of dietary yeast levels of the averaging method was as follows:

\[(E)> (D)> (C)> (B)> (A)\]

So, according to this method, group E (1 g kg\(^{-1}\)) had the best performance compared to the others, followed by yeast levels of 0.75, 0.5, 0.25 and 0.

In this method, all production responses have equal weight and their weight of importance is not considered.

Weighted averaging

Weighted averaging highlights the performance criteria that the decision maker feels are more important than others. The chosen values, weight of importance, and normalized weights are shown in Table 3. First, the weight of importance was determined. The point one was assigned to the least important production criteria in the set. In this example, the decision maker chose Haugh’s unit as being the least important criteria. Then, the next least important criteria, egg shell thickness, was assigned to point two, showing how much more important it is than the least important criteria, and so on, until all criteria were assigned a weight of significant. The total of these weights (n=55) was determined, and the weights were normalized by dividing the weight of importance for each criterion by this total (Table 3). The weighted membership values of all criteria for all groups are presented in Table 4.

For example, the value for feed consumption of group (A) was determined by multiplying the normalized weight from Table 3 (0.109) by the fuzzy membership value from Table 2 (0.803) to obtain 0.088. The calculated values were summed (e.g. 0.088+ 0.034 ... + 0.282 = 0.247) for each strain. The resulting decision set (D), made up of these summed values for each strain, is:

\[ D = \{0.247/(A), 0.281/(B), 0.676/(C), 0.701/(D) \text{ and } 0.786/(E)\} \]

The largest value of the decision set was 0.786, which was the membership value for group (E). The weighted ranking using this decision approach was:

\[(E)> (D)> (C)> (B)> (A)\]

As mentioned above, according to this method all criteria were assigned a weight of significance; however, the decision maker judges which affect is the least advantageous.

Ordered weighting averaging

Ordered weighted averaging is another way to assess production criteria (Yager, 1988).

Table 3. Normalized weights for selecting commercial broiler strain.

| Criteria | Weight of importance | Normalized weight |
|----------|----------------------|-------------------|
| Feed intake, g/day | 6 | 6/55=0.109 |
| Egg production, % | 9 | 9/55=0.164 |
| Average egg weight, g | 7 | 7/55=0.127 |
| Egg mass, g | 10 | 10/55=0.182 |
| Feed conversion | 8 | 8/55=0.145 |
| Feed cost per kg egg, Rial | 5 | 5/55=0.091 |
| Egg shell thickness | 2 | 2/55=0.036 |
| Specific gravity | 4 | 4/55=0.073 |
| Egg shell stretch | 3 | 3/55=0.055 |
| Haugh unit | 1 | 1/55=0.018 |
| Total | 55 | 1.000 |

Rial, Iranian currency.

Table 4. Weighted average of fuzzy set membership values for the production criteria of laying hens.

| Criteria | Rank | Weight | 0.25 (A) | 0.5 (C) | 0.75 (D) | 1 (E) |
|----------|------|--------|-----------|---------|---------|-------|
| Feed intake, g/day | 6 | 0.109 | 0.087 | 0.044 | 0.109 | 0.000 | 0.088 |
| Egg production, % | 9 | 0.164 | 0.034 | 0.000 | 0.062 | 0.164 | 0.144 |
| Average egg weight, g | 7 | 0.127 | 0.000 | 0.127 | 0.103 | 0.077 | 0.122 |
| Egg mass, g | 10 | 0.182 | 0.000 | 0.035 | 0.089 | 0.182 | 0.174 |
| Feed conversion | 8 | 0.145 | 0.000 | 0.002 | 0.130 | 0.130 | 0.145 |
| Feed cost per kg egg, Rial | 5 | 0.091 | 0.060 | 0.000 | 0.091 | 0.077 | 0.066 |
| Egg shell thickness | 2 | 0.036 | 0.028 | 0.036 | 0.006 | 0.014 | 0.000 |
| Specific gravity | 4 | 0.073 | 0.020 | 0.003 | 0.073 | 0.002 | 0.000 |
| Egg shell stretch | 3 | 0.055 | 0.000 | 0.030 | 0.011 | 0.055 | 0.009 |
| Haugh unit | 1 | 0.018 | 0.018 | 0.005 | 0.003 | 0.000 | 0.018 |
| Decision | 55 | 0.247 | 0.281 | 0.676 | 0.701 | 0.786 |

Yeast supplementation, (A) 0 g/kg-1diet; (B) 0.25 g/kg-1diet; (C) 0.5 g/kg-1diet; (D) 0.75 g/kg-1diet; (E) 1 g/kg-1diet. Rial, Iranian currency.
According to this method, apart from the production criteria, the weights of importance are presented in descending order. These weights put emphasis on the best responses of each level of yeast. Table 5 shows the ordered weighting of production criteria that is calculated as follows. The normalized weights from Table 3 were put in descending order (e.g., 0.185, 0.164, 0.145, 0.109 ... 0.018).

The fuzzy membership values from Table 2 for each strain were also put in descending order (e.g. for group (A): 1.00, 0.803 ... 0.000). The ordered weights were then multiplied by the ordered fuzzy membership values (e.g. for group (A): 0.185 × 1.000 = 0.185, 0.164 × 0.803 = 0.1338, and ... 0.018 × 0.00 = 0.000). The values resulting from the multiplication of the weight of importance and the ordered membership value were summed for each group (e.g. for group (A): 0.557) as shown in Table 5.

Therefore, the decision set (D) for this analysis was:

\[
D = \{0.557/(A), 0.526/(B), 0.779/(C), 0.780/(D) and 0.851/(E)\}
\]

The largest ordered weighted average of the decision set (0.851) was that of dietary yeast level of 1 g kg⁻¹. The ranking of yeast supplementation levels by ordered weighted decision approach was: (E)>(D)>(C)>(B)>(A).

In this method, similar to weighted averaging, production criteria are weighted according to the decision maker’s judgement. Since different people are involved in the decision making process, some make poor decisions and some make good decisions according to their individual experience. Therefore, neither can this method correctly show the best level of yeast supplementation in laying hens diet.

**The ideal point methods**

One of the most popular ideal point methods is the technique for order preference by similarity to the ideal solution (TOPSIS) developed by Hwang and Yoon (1981). According to this method, a decision matrix based on fuzzy set membership values was set as shown in Table 6. The memberships of the matrix were measured according to following formula:

\[
n_{ij} = \frac{\alpha_{ij}}{\sqrt{\sum \alpha_{ij}^2}}
\]

Table 7 presents the order preference by similarity to ideal solution method weighting of the production criteria which was calculated as follows:

1. Calculating the probability distribution \(P_j\)

\[
P_j = \frac{\alpha_j}{\sum \alpha_i}
\]

2. Calculating the entropy value \(E_i\)

\[
E_i = -\frac{1}{k} \sum [p_i \ln p_i]
\]

3. Calculating the amount of uncertainty \(d_i\)

\[
d_i = 1 - E_i
\]

4. Calculating the weights

\[
W_j = \frac{d_j}{\sum d_j}
\]

Finally, setting the decision set (D) for this analysis was calculated by multiplying the probability distribution \(P_j\) matrix with weighting matrix according to multiple matrices. In these methods, the decision set (D) for this analysis was:

\[
D = \{0.01556/(A), 0.019268/(B), 0.01532/(C), 0.01255/(D) and 0.01514/(E)\}
\]

Yeast supplementation, (A) 0 g/kg⁻¹diet; (B) 0.25 g/kg⁻¹diet; (C) 0.5 g/kg⁻¹diet; (D) 0.75 g/kg⁻¹diet; (E) 1 g/kg⁻¹diet.

**Table 5. Ordered weighted averages of fuzzy set membership values for the production criteria of laying hens.**

| Weight | 0 (A) | 0.25 (B) | 0.5 (C) | 0.75 (D) | 1 (E) |
|--------|-------|----------|---------|----------|-------|
| 0.185  | 0.185 | 0.185    | 0.185   | 0.185    | 0.185 |
| 0.167  | 0.1338| 0.1667   | 0.1667  | 0.1667   | 0.1667|
| 0.148  | 0.1152| 0.0805   | 0.1481  | 0.1481   | 0.1481|
| 0.111  | 0.0734| 0.0444   | 0.0994  | 0.0994   | 0.0994|
| 0.093  | 0.0189| 0.0177   | 0.0451  | 0.0560   | 0.0816|
| 0.074  | 0     | 0.0035   | 0.0283  | 0.0288   | 0.0594|
| 0.056  | 0     | 0.0060   | 0.0108  | 0.0013   | 0.0092|
| 0.037  | 0     | 0        | 0.0058  | 0        | 0     |
| 0.018  | 0     | 0        | 0.0027  | 0        | 0     |
| Decision| 0.557 | 0.526    | 0.779   | 0.780    | 0.851 |

Yeast supplementation, (A) 0 g/kg⁻¹diet; (B) 0.25 g/kg⁻¹diet; (C) 0.5 g/kg⁻¹diet; (D) 0.75 g/kg⁻¹diet; (E) 1 g/kg⁻¹diet.

**Table 6. Decision matrix based on fuzzy set membership values for the production criteria in Table 1 according to technique for order preference by similarity to ideal solution method.**

| Criteria                | 0 (A) | 0.25 (B) | 0.5 (C) | 0.75 (D) | 1 (E) |
|-------------------------|-------|----------|---------|----------|-------|
| Feed intake, g/day      | 0.498 | 0.501    | 0.496   | 0.504    | 0.498 |
| Egg production, %       | 0.496 | 0.492    | 0.499   | 0.511    | 0.509 |
| Average egg weight, g   | 0.495 | 0.503    | 0.501   | 0.500    | 0.503 |
| Egg mass, g             | 0.492 | 0.495    | 0.501   | 0.511    | 0.510 |
| Feed conversion         | 0.501 | 0.501    | 0.489   | 0.489    | 0.487 |
| Feed cost per kg egg, Rial | 0.4997| 0.5043   | 0.4974  | 0.4984   | 0.4987|
| Egg shell thickness     | 0.5015| 0.5032   | 0.4967  | 0.4985   | 0.4955|
| Specific gravity        | 0.4998| 0.4990   | 0.5013  | 0.4993   | 0.4993|
| Egg shell stretch       | 0.4848| 0.5032   | 0.4967  | 0.4985   | 0.4955|
| Haugh unit              | 0.5151| 0.4976   | 0.4952  | 0.4918   | 0.5145|

Yeast supplementation, (A) 0 g/kg⁻¹diet; (B) 0.25 g/kg⁻¹diet; (C) 0.5 g/kg⁻¹diet; (D) 0.75 g/kg⁻¹diet; (E) 1 g/kg⁻¹diet. Rial, Iranian currency.

**Table 7. Technique for order preference by similarity to ideal solution results of fuzzy set membership values for the production criteria of laying hens.**

| Criteria                | Weight |
|-------------------------|--------|
| Feed intake, g/day      | 0.01556|
| Egg production, %       | 0.019268|
| Average egg weight, g   | 0.01532|
| Egg mass, g             | 0.011952|
| Feed conversion         | 0.022120|
| Feed cost per kg egg, Rial | 0.001258|
| Egg shell thickness     | 0.000110|
| Specific gravity        | 0.001630|
| Egg shell stretch       | 0.030100|
| Haugh unit              | 0.194600|
| Decision                | 0.280990|
| 0.25                    | 0.423520|
| 0.5                     | 0.357600|
| 0.75                    | 0.720730|
| 1                       | 0.623233|

Rial, Iranian currency.
D = \{0.281/(A), 0.424/(B), 0.358/(C), 0.721/(D) \text{ and } 0.623/(E)\}

The ranking of dietary yeast levels using TOPSIS was:

\[(D) > (E) > (B) > (C) > (A)\]

In TOPSIS, all criteria were assigned a weight of significance and weighting is based on the entropy method. The decision maker cannot influence selection so the criterion with the highest distribution has the most weight.

**Conclusions**

Multicriteria decision analysis is a suitable tool for examining data that are determined in various units. However, the method of analysis can differ depending on the types of data. Moreover, the results obtained by the methods of equally likely, weighted average, and ordered weighted averages showed that laying hens fed diet supplemented with 1 g kg\(^{-1}\) yeast had the best performance over the course of the experiment followed by the levels of 0.75, 0.5, 0.25 and 0. But results obtained by the maximin and TOPSIS methods indicated the best performance to be 0.5 and 0.75 dietary levels, respectively. The difference between the results obtained from maximin and the other methods is due to the single production criteria used in this technique, while overall performance is not considered. Since the decision makers (e.g. feed industry vs farmer) always assign a different priority to different traits, therefore the maximin method is not appropriate. On the contrary, TOPSIS seems a more scientific test since the weighting procedure is based on the entropy method and the decision maker does not influence the result. But in weighted average and ordered weighted averages, the decision maker ranks the criterions, and this has an effect on the results. As shown in Table 7, the results of decision making in TOPSIS for yeast levels of 0.75 and 1 g kg\(^{-1}\) diet are 0.72 and 0.62, respectively, i.e. almost similar. Thus, it should be suggested that the farmers use yeast levels of 0.75 and 1 g kg\(^{-1}\) of diet.

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