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Effectiveness of Decision Support System for Hydroponic Plant Nutrient Selection Using Apriori Algorithm Method

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Abstract: Hydroponics is an agricultural system that uses water as its growing medium by adding nutrients to plants without using soil. In hydroponic cultivation, the thing that needs to be considered is the provision of an optimal dose of nutrient solution as a food source for plants. The provision of nutrients that are not in accordance with the needs of plants results in plants stopping growing, so that plants do not take care of each other. The type of nutrition commonly used in hydroponic plants is AB mix. However, the use of AB mix as a hydroponic nutrient also has disadvantages, namely synthetics and the price of AB mix nutrients are quite expensive. Therefore, alternative nutrients are needed that have the potential to be used as hydroponic nutrients. By analyzing hydroponic plant assessment data so that the rules of linkage between combinations of goods are found and form a pattern of itemset combinations with apriori algorithm. The association technique aims to find matching links in the database. From the results of data mining calculations using apriori algorithms, nutrient assessment data on hydroponic plants with the minimum support 20% and the minimum confidence 70%, formed five rules on hydroponic plant nutrition. One of the best rules is that AB mix nutrition is used on cucumber, spinach, celery, and kailan plants, so with 100% probability that POC nutrients will be good to also use on cucumber, spinach, celery, and kailan plants.

Keywords: Aprioiri Algorithm; Association Rule; Decision Support System Hydroponics; Nutrition;

INTRODUCTION

Hydroponics is an agricultural system that uses water as its growing medium by adding nutrients to plants without using soil (Irawan, 2021). There are several systems in hydroponics including *the Wick System* (axis system), DFT (*Deep Low* Technique), NFT (*Nutrient Film Technique*).(Agustin & Indrawan, 2021)

In hydroponic cultivation, the thing that needs to be observed is the provision of nutrient water and the maximum dose as the basis of food for plants (Haikal et al., 2021). The provision of nutrient factors that are not in accordance with the wishes of plants causes plants to finish developing, yellowing and falling leaves as a result of plants not protecting each other and the dimensions of the leaves shrink.(Romalasari & Sobari, 2019)

The type of nutrition that is often used in hydroponics is AB mix. However, the use of AB mix as a hydroponic nutrient also has disadvantages, it is chemical and the price of AB mix nutrients is quite expensive, approximately 100. 000 IDR per pack. Until then, it takes nutrient replacement nutrients that have the potential to be used as hydroponic nutrients. To overcome this problem, a system is needed that can help in ensuring the right nutrition in hydroponic plants. This matter can be known by analyzing the nutrients that have been used first. As a result, a conclusion of nutrition that fits in hydroponic plants is derived from the provisions of the federation pattern. The management of existing information can be tried using Information Mining apriori Algorithm procedures.(Ilhamdi et al., 2020)

The association pattern obtained is sourced from the benchmark of support, confidence, and lift in order to obtain the best rules that can be used as a benchmark in determining nutrients in hydroponic plants (Prasetya et al., 2022). This is the reason behind the effectiveness of decision support system for determining the right nutrition in hydroponic plants to replace the solution so that the fulfillment of the supply of nutrients as desired by the plant.(Wardah & Fitrianah, 2018)

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LITERATURE REVIEW

In the first research (Dewayanti, 2018), carried out research at SMP N 36 Semarang by applying mining information to student assessments using the association rule algorithm apriori method. The research aims to ascertain the pattern of bonding of subject numbers with other subjects.The final result proved through the elevator ratio experiment the totality of more than 1 resulted in a large association rule value.

Next,(Jannah & Mansyur, n.d.) also uses apriori algorithm as a marketing strategy at Giant. The association provision wants to share data on the combination of products that are of interest to the client, resulting in creating 8 association conditions by associating 7 items. This previous research was further used as a reference by researchers.

Data mining is a process of extracting or mining datasets to obtain interesting patterns from the data (Rizaldi & Adnan, 2021). Some parts of data mining are description, estimation, prediction, classification, clustering, and association. Apriori algorithm belong to the association rule type in data mining (Salam, 2018). Association rule mining methods information mining in creating provisions for a combination of items (Fitriani et al., 2022). One of the steps of association analysis that attracts the attention of many researchers in creating efficient algorithms is frequent pattern mining. This means that whether or not something can be known as 2 measuring thrusts is support and confidence.(Herti Yani & Pareza Alam Jusia, 2018)

The following are the definitions that need to be known in the association rule method:

Definition 1

The support of an itemset A is the proportion of events that all items in set A are retrieved simultaneously.

$$S(A) = \frac{itemset\ frequency\ (A)}{total\ transaksi}$$

$$= \frac{1}{N}\sum_{i=1}^{N}\prod_{a\in\lambda} x_{ia} \geq \text{minimum support} \qquad (1)$$

Where

A = itemset

N = amount of the total transaction

x_{ia}= an i- item on the a- transaction

λ = integer on A

Definition 2

The support of a rule (A⇒B) is the proportion of events where the items in Adan in B occur simultaneously. Denoted S (A⇒B). then based on (1) it is formulated as follows :

$$S(A \Rightarrow B) = \frac{1}{N}\sum_{i=1}^{N}\prod_{p\in\lambda\cup\beta} x_{ip} \qquad (2)$$

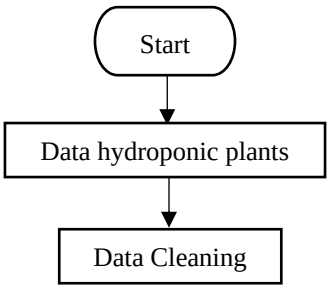
Definition 3

The confidence of a rule (A⇒B) is a measure of the accuracy of an association rule. Denoted by C(A⇒B). The formula of C(A⇒B) is :

$$C(A \Rightarrow B) = \frac{\sum_{i=1}^{N}\prod_{p\in\lambda\cup\beta} x_{ip}}{\sum_{i=1}^{N}\prod_{a\in\lambda} x_{ia}} \geq \text{minimum confidence} \qquad (3)$$

METHOD

In this research, information to be monitored is obtained from nutritional information in hydroponic plants along with the results of the development of good hydroponic plants in the form of vegetables or fruits. This information is inferior information obtained directly from the research site, which is in the form of assessment data on the results of the development of hydroponic plants that are given nutrients.



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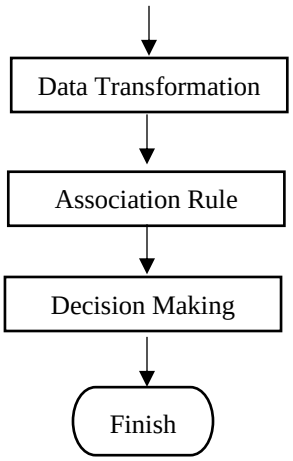

Figure 1. Research Flowchart

The numerical information used in this research was obtained from the evaluation information of Syifa Hydroponics to the results of the development of the number of leaves in hydroponic plants of vegetables and fruits. The value used to inscribe a number is tens (maximum 100). Making Frequent Itemsets by ensuring minimal support and minimal confidence first(Andini et al., 2022). After that, calculate the support value on the candidate k- itemset. Subsequently, it was tried to calculate the confidence of each k- itemset to ascertain whether the candidate could be used as a provision of the association or not.

RESULT

The value used to inscribe a number is tens. The evaluation was submitted by the Syifa Hidroponik which was observed from the development of vegetables and fruits in hydroponic plants using 3 nutrients that are often used.

Table 1. Nutritional Assessment of Hydroponic Plants

No.	Plant Name	Ab mix	POC	NPK
1	Lettuce	85	74	82
2	Water Spinach	92	70	71
3	Pak Choy	89	75	82
4	Caism	88	77	81
5	Tomatoes	85	81	85
6	Cucumber	80	82	86
7	Spinach	80	82	84
8	Celery	79	83	77
9	Shallot	88	90	82
10	Garlic	84	83	71
11	Eggplant	83	82	81
12	Chilli	94	68	60
13	Mung Beans	82	77	87
14	Kailan	80	82	91
15	Melon	82	83	81

Apriori algorithms do not identify numerical data. Thus, the collected number data will be classified based on the range determined by the mean and standard deviation in the assessment data for hydroponic plants. Researchers sorted out 3 classifications of information, namely A (high), B (medium), C (low). Using Microsoft Excel, it can be concluded by the table below:

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Table 2. Range of Nutrient Assessment Data in Hydroponic Plants

Range	Hydroponic Plant Nutrition		
	AB mix	POC	NPK
A	≥ 89	≥ 85	≥ 88
B	80 – 89	73,5 -85	72 – 88
C	≤ 80	≤73,5	≤ 72

Next, using Microsoft Excel performed transformations whose results are displayed in table 3.

Table 3. Nutrient Assessment Data in Hydroponic Plants After Data Transformation

NO.	Hydroponic Plant Nutrition		
	AB mix	POC	NPK
1.	B	B	B
2.	A	C	C
3.	A	B	B
4.	B	B	B
5.	B	B	B
6.	C	B	B
7.	C	B	B
8.	C	B	B
9.	B	A	B
10.	B	B	B
11.	B	B	B
12.	A	C	B
13.	B	B	B
14.	C	B	A
15.	B	B	B

The Apriori algorithm is carried out in two stages, namely the search for frequent itemsset and the formation of association rules from those frequent itemsets. To carry out these stages, minimum support and minimum confidence values are given. In this study, the minimum support = 20% and the minimum confidence = 70% determined by the researcher and X = {X_1,X_2,...,X_{15}} is the set of all plants owned by Syifa Hidroponik.

The first step is the calculation of the number of items from the data of table 3.

Table 4. Calculation of the Number of Items

Range	Hydroponic Plant Nutrition		
	AB mix	POC	NPK
A	3	1	1
B	8	12	13
C	4	2	1

Using apriori algorithm technique, the support calculation of each 1-itemset is carried out based on equation 1. Then, compare it to the minimum support for getting a frequent 1-itemset (F_1).

$$F_1 = \{x_j \mid S(x_j) = \frac{1}{15}\sum_{i=1}^{15} x_{ij} \geq \text{minimum support} = 20\%\}$$

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Table 5. 1-itemset and its Support

1.	Support AB mix A	$\frac{3}{15} = 0{,}2 = 20\%$
2.	*Support* AB mix B	$\frac{8}{15} = 0{,}53333333 = 53{,}33\%$
3.	*Support* AB mix C	$\frac{4}{15} = 0{,}26666667 = 26{,}67\%$
4.	*Support* POC A	$\frac{1}{15} = 0{,}06666667 = 6{,}67\%$
5.	*Support* POC B	$\frac{12}{15} = 0{,}8 = 80\%$
6.	*Support* POC C	$\frac{2}{15} = 0{,}13333333 = 13{,}33\%$
7.	*Support* NPK A	$\frac{1}{15} = 0{,}06666667 = 6{,}67\%$
8.	*Support* NPK B	$\frac{13}{15} = 0{,}86666667 = 86{,}67\%$
9.	*Support* NPK C	$\frac{1}{15} = 0{,}06666667 = 6{,}67\%$

Based on Table 5. the frequent set of 1-itemset (F_1) is obtained, namely:

F_1 = { AB mix A, AB mix B, AB mix C, POC B, NPK B}

Furthermore, the remaining items are combined by two items into 2-itemset, and again calculated Support from the item using equation 2. the results of the 2-Itemset calculation are shown in table 6.

Table 6. *2-itemset* and its *Support*

No.	2-itemset	Support	Support 100%
1.	AB mix A + POC B	1	$\frac{1}{15} = 0{,}06666667 = 6{,}67\%$
2.	AB mix A + NPK B	2	$\frac{2}{15} = 0{,}13333333 = 13{,}33\%$
3.	AB mix B + POC B	7	$\frac{7}{15} = 0{,}46666667 = 46{,}67\%$
4.	AB mix B + NPK B	8	$\frac{8}{15} = 0{,}53333333 = 53{,}33\%$
5.	AB mix C + POC B	4	$\frac{4}{15} = 0{,}26666667 = 26{,}67\%$
6.	AB mix C + NPK B	3	$\frac{3}{15} = 0{,}2 = 20\%$
7.	POC B + NPK B	11	$\frac{11}{15} = 0{,}73333333 = 73{,}33\%$

Based on Table 6. the set of frequent 2-itemsets (F_2) is obtained, namely:

F_2 = { AB mix B+POC B, AB mix B+NPK B, AB mix C+POC B, AB mix C+NPK B, POC B+NPK B}

The set of candidates of the frequent 3-itemsets can be seen in table 7.

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Table 7. *3-itemsets* and its Support

3-*itemset*	*Support*	*Support* 100%
AB mix B + POC B + NPK B	7	$\frac{7}{15} = 0{,}46666667 = 46{,}67\%$
AB mix C + POC B + NPK B	3	$\frac{3}{15} = 0{,}2 = 20\%$

Since all candidates from the *frequent* 3-itemsets have a non-frequent subset, there are no candidates left or the set of candidates from the *frequent* 3-itemsets = ∅. The formation of the *Association Rule* is done by determining the *Confidence* of the *Frequent Itemset* based on equation 3. However, on the other hand, this value can cause errors, where the *confidence* value produced is quite high due to the high *support* value even though the antecedents and consequents are mutually independent. Another measure that can explain better than confidence value is the lift ratio value.(Hikmawati et al., 2021)

Table 8. *Confidence* Values of *Frequent Itemsets*

No.	*Itemset*	*Confidence*	*Lift*
1.	**AB mix B + POC B**	$\mathbf{\frac{7}{8} = 0{,}875 = 87{,}5\%}$	$\mathbf{\frac{87{,}5}{80} = 1{,}09}$
2.	**AB mix B + NPK B**	$\mathbf{\frac{8}{8} = 1 = 100\%}$	$\mathbf{\frac{100}{86{,}67} = 1{,}15}$
3.	**AB mix C + POC B**	$\mathbf{\frac{4}{4} = 1 = 100\%}$	$\mathbf{\frac{100}{80} = 1{,}25}$
4.	AB mix C + NPK B	$\mathbf{\frac{3}{4} = 0{,}75 = 75\%}$	$\mathbf{\frac{75}{86{,}67} = 0{,}86}$
5.	**POC A + NPK B**	$\mathbf{\frac{1}{1} = 1 = 100\%}$	$\mathbf{\frac{100}{86{,}67} = 1{,}15}$
6.	**POC B + NPK B**	$\mathbf{\frac{11}{12} = 0{,}916 = 91{,}67\%}$	$\mathbf{\frac{91{,}67}{86{,}67} = 1{,}05}$

From the information above, if the lift ratio value is greater than 1, it indicates the benefit of the rule. The higher the value of the lift ratio, the greater the strength of the association. By setting the minimum support value at 20% and the minimum confidence at 70%, five rules are obtained. The best combination of nutrients is {AB mix C, POC B} with 100% confidence level and has the highest lift value of 1.25.

DISCUSSIONS

After obtaining strong association rules, an interpretation of each strong association rule is carried out. This interpretation is useful for providing information regarding the right combination of nutrients in hydroponic plants.

1. Interpretation of Rule 1 : " If AB mix nutrition is used in lettuce, caism, tomatoes, garlic, eggplant, mung bean, and melon, then with 87.5% probability that POC nutrients will be good also used in lettuce, caism, tomato, garlic, eggplant, mung bean, and melon plants."
2. Interpretation of Rule 2 : " If AB mix nutrition is used on lettuce, caism, tomatoes, shallot, garlic, eggplants, green beans, and melons, then with 100% probability that NPK nutrients will also be good to use on lettuce, caism, tomatoes, shallot, garlic, eggplant, mung bean, and melon.
3. Interpretation of Rule 3: "If AB mix nutrition is used on cucumber, spinach, celery, and kailan plants, then with 100% probability that POC nutrition will be good to also be used on cucumber, spinach, celery, and kailan plants.
4. Interpretation of Rule 4 : " If POC nutrition is used in shallot plants, then with 100% probability that good NPK nutrients are also used on shallot plants.
5. Interpretation of Rule 5: " If POC nutrition is used on lettuce, pak choy, caism, tomatoes, cucumber, spinach, celery, garlic, eggplant, mung bean, and melon plants, then with 91.67% probability that good NPK nutrients are also used in lettuce, pak choy, caism, tomatoes, cucumber, spinach, celery, garlic, eggplant, mung bean, and melon.

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CONCLUSION

From the results of data mining calculations using Apriori algorithm, nutrient assessment data in hydroponic plants with the minimum support of 20% and the minimum confidence of 70%, form five rules on nutrition hydroponic plants. One of the best rules is that AB mix nutrition is used on cucumber, spinach, celery, and kailan plants, so with 100% probability that POC nutrients will be good to also be used on cucumber, spinach, celery, and kailan plants. The Apriori algorithm method has been successfully implemented on nutrient assessment data in hydroponic plants as a decision making. The specified support and confidence values will affect the accuracy in rule formation, the higher the support and confidence values, the more accurate the rule will be.

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