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Research Article

Morphological Characterization and its Relationship with Preference for Pineapple in Labuhan Batu Regency, Indonesia

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Abstract

Background and Objective: The type of pineapple in Labuhan Batu Regency, North Sumatra Province, has specific local characteristics, but the consumer preferences are not yet known. Therefore, this study was conducted to determine the morphological characterization and its relationship with consumer preferences. **Materials and Methods:** The research method of characterization was carried out by survey, determining the location of purposive sampling. Morphological characters using the International Union for the protection of new varieties of plants. Agglomerative hierarchical analysis. Consumer preferences using judgment sampling samples, conjoint data analysis. Pineapple fruit attributes, taste, size, aroma, colour and texture. **Results:** The results show a combination of consumer preferences: Sweet taste, large size, strong aroma, soft and smooth texture and yellowish-green colour. Accessions have characters according to consumer preferences, namely the character of sweetness in AN₃, AN₄ and AN₈. Large characters on AN₇, AN₁₃ and AN₁₄. Strong aroma character and soft/soft texture on AN₃ and AN₄. The character of ripe fruit colour is yellowish-green/light yellow in AN₁, AN₂, AN₃, AN₄, AN₅, AN₆, AN₁₀, AN₁₁, AN₁₂, AN₁₃, AN₁₄, AN₁₅, AN₁₆, AN₁₇ and AN₁₈. The results of morphological identification obtained superior accessions AN₃ and AN₄ with a sweet taste, strong aroma, soft and smooth texture and yellowish-green/light yellow ripe colour. **Conclusion:** So, it is concluded that pineapples in the regency do not yet fully have the attributes and levels consumers want because the large pineapples are not included in them.

Key words: Identification, characterization of morphology, relationships, consumer preferences, attributes, pineapple

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Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

Pineapple (*Ananas comosus* (L.) Merr.) is a tropical fruit from the Bromeliaceae family with high economic value after banana¹. Indonesia has a comparative advantage as the largest pineapple exporter in the world. Most of the pineapples are exported in the form of canned pineapples².

North Sumatra province is the province with the 4th largest peatland, about 325,296 hectares³. The largest peatlands are located on the east coast, namely in the Labuhan Batu District area of 192 thousand ha. Pineapple is very tolerant of high soil acidity levels, adaptive to tolerant peat swampland pH 3-4. Areas in Labuhan Batu Regency, pineapple plants, include Panai Tengah District and Bilah Hilir District³.

Morphological characterization of pineapple (*ananas comosus*) genetic resources from Benin, showed the existence of clear morphological variation among pineapple cultivars which could be used for fruit improvement through clonal selection and farmer training on propagule production and crop homogeneity. 'Singapore Spanish' and 'Green Spanish' could be promoted for their attractive shell colour and long shelf life⁴.

Thailand, Philippines, Mexico, Costa Rica, Chile, Brazil, China, Indonesia, Hawaii, India, Bangladesh, Nigeria, Kenya, Democratic Republic of Congo, Ivory Coast, Guinea, Dominican Republic and South Africa are the leading pineapple producing countries. Among the countries, the Philippines, Thailand, Costa Rica, Indonesia, Chile, Ivory Coast and South Africa are the major exporters of pineapple in the world market. The quality of pineapple varies due to cultivation technique, growing environment and variety. Good quality pineapple grows well in acidic loams, sandy loams and clay loams soils under warm and humid climates with sunny days and cool nights⁵.

Pineapple is also a rich source of minerals and vitamins that offer several health benefits. Ranked third behind banana and citrus, the demand for pineapple has greatly increased within the international market⁶.

Although sufficient data have been obtained on pineapple production, it is not yet known with certainty the varieties they have been cultivating. This is because farmers in the area do not obtain seeds from the central seedling center but instead carry out continuous planting of pineapples whose seeds come from other farmers.

According to reports⁷, consumer behaviour investigation aims to find consumer attitudes in their decision to buy or ignore a product. Furthermore, according to reports⁸, in marketing consumer preferences are defined as the subjective

tastes, as measured by utility, of various bundles of goods. They permit the consumer to rank these bundles of goods according to the levels of utility they give the consumer.

Pineapple is one type of fruit that is liked by the community. In Indonesia, pineapple has a high potential as an export commodity⁹. Pineapple pane is one of the souvenirs for travellers to Labuhan Batu Regency and an icon of the Regency, which is flanked by North Labuhan Batu Regency (Labura) and South Labuhan Batu Regency (Labusel).

Based on this opinion, it is necessary to research morphological characterization and its relationship with consumer preferences for pineapple in Labuhan Batu Regency, North Sumatra Province. So, this research becomes an initial reference to find out whether local pineapple cultivated by farmers and its morphological characters meet consumer preferences in Labuhan Batu Regency.

MATERIALS AND METHODS

Study area: This research was conducted in Labuhan Batu Regency, North Sumatra Province. The research starts from February-August, 2021. The material used in the morphological characterization research is pineapple plants belonging to farmers in Panai Tengah District and Bilah Hilir District, Labuhan Batu Regency.

Instruments: The tools used in this research are a camera, GPS Garmin 64s, meter, calliper, scale, ruler, refractometer, machete, label paper, white cloth, questionnaire, books and stationery.

Morphological characterization: Research on the morphological characterization of pineapple plants using survey methods and purposive sampling¹⁰ in 2 sub-districts in Labuhan Batu Regency, including Panai Tengah and Bilah Hilir sub-districts. Next, identify the morphological characters of pineapple plants in Labuhan Batu Regency, North Sumatra Province.

Methodology: The sampling method for morphological characterization is carried out by the judgment sampling method, namely the determination of samples based on certain criteria so that the representative of the population can be accounted¹¹. The criteria include a minimum land area of 1 range (20×20 m) and active in farmer groups, 1-3 years old plants, have been fruitful before and the plant is bearing fruit with ripe fruit a week before harvest. The criteria for harvesting

pineapples are open fruit crown, shrivelled fruit stalk, flatter eye, large and round shape, yellow fruit base colour and a distinctive and fragrant pineapple aroma. Data were collected by observing the morphological characters qualitatively and quantitatively (Table 1), based on the pineapple plants¹², International Union for the protection of new varieties of plants manual.

Statistical analysis: Standardized qualitative and quantitative data were analyzed using IBM SPSS (Statistical Program for Social Science) version 20 with cluster analysis to determine each sample's degree of relationship accession. Cluster analysis is used to visualize multivariate data (from the measured parameters. Cluster analysis produces a dendrogram that is used to assess the pattern of diversity from survey data. Then, cluster analysis is carried out using the agglomerative hierarchical clustering method using the formula below in Aziz *et al.*¹³.

$$d_{i,j} = \sqrt{\sum_{k=1}^p (x_{ik} - x_{jk})^2}$$

Where:

d_{ij} = Distance between object i and object j

x_{ik} = Value of object i on the variable to k

x_{jk} = Value of object j in the variable to k

p = Number of cluster variables

Furthermore, the value of phenotypic diversity is calculated according to the following Eq.¹⁴:

$$\sigma^2 p = \frac{\sum (x_i - x)^2}{N}$$

Where:

$\sigma^2 p$ = Variety of phenotypes

x_i = Sample value-i

x = Population mean

N = Number of populations tested

Furthermore, the standard deviation of phenotype diversity is calculated based on the formula:

$$Sd\sigma^2 p = \sqrt{\sigma^2 p}$$

$Sd\sigma^2 p$ = Standard deviation of phenotypic diversity

The assessment criteria for the breadth and narrowness of the variance are calculated based on¹³ as follows:

- When $\sigma^2 p > 2Sd\sigma^2 p$ means that the wide variety (various)
- When $\sigma^2 p < 2Sd\sigma^2 p$ means that narrow variance (uniform)

Consumer preferences

Methodology: The method of determining the sample of consumer preferences is carried out using the judgment sampling method, namely, determining the sample from a population-based on certain criteria so that its representation of the population can be accounted¹⁵. Knowledge of sampling methods is essential to design quality research. Critical questions are provided to help researchers choose a sampling method¹⁶.

The number of sample taken as many as 72 representative consumer samples representing each sub-district spread over Labuhan Batu Regency. Respondents were selected with the following criteria, aged more than 17 years, respondents were consumers of pineapples who at the time of the study were purchasing pineapples at the sampling locations, namely markets in each sub-district, in one family, only one person was taken as a respondent, so that do not affect each other in answering the questionnaire. The basic model of conjoint analysis formulated systematically can be seen as follows¹⁷:

$$\mu(x) = \sum_{i=1}^m \sum_{k=1}^{k_i} a_{ij} k_{ij}$$

where:

$\mu(x)$ = Utility (use value) total of each stimulus/combination

a_{ij} = Utility (usability value) from attribute to -i (i = 1, 2, 3....m) and level -j (j = 1, 2, 3, k)

k = Number of attribute levels i

m = Number of attributes

k_{ij} = 1, if level to -j from attribute to -i happen 0, if not

Statistical analysis: The method of collecting consumer preference data, namely primary data and secondary data. The data analysis method is a conjoint analysis using SPSS software.

RESULTS

Phenotypic diversity: Phenotype diversity in 18 samples of pineapple plants from Panai Tengah District and Bilah Hilir District, Labuhan Batu Regency. It can be analyzed based on comparing the value of phenotype diversity with the standard deviation as in Table 2 and 3.

Based on the results of the analysis of phenotypic diversity by comparing twice the standard deviation value

Table 1: Qualitative and quantitative characters of pineapple plants were observed in this study

Characters		
Organ	Qualitative	Quantitative
Plant	Growth habit	Number of leaves (sheet) Plant: Height to the fruit base (cm) Plant: Number of underground suckers Plant: Number of aerial suckers on stem Number of aerial suckers on stem Size of aerial suckers on the stem (cm)
Leaf	Green color of upper side Trichome on lower side Leaf spines Position of spines on margin Leaf color of spines	Long leaf (cm) Wide leaf (cm) Density leaf spine (mm) Size leaf spine (mm)
Flower	Colour of apex	Flower stalk length (cm) Flower stalk diameter (cm) Flower petals length (cm) Long crown (cm)
Crown	Crown shape	Number of crowns Crown length Size
Fruit	Immature fruit color Fruit shape Fruit ripe color Fruit flesh color Fruit tip shape	Long fruit (cm) Heavy fruit (grams) Fruit eye size (mm) Diameter fruit (cm)
Flesh of fruit	Evenness of fruit flesh color Fruit texture Hard nature of fruit flesh Fruit flesh aroma	Rate fruit flesh water (%) Sweetness level of fruit flesh (brix %)

Data from international union for the protection of new varieties of plants, 2013

with the value of phenotype variance, it can be seen that there are 9 characters with broad phenotypic diversity criteria, which means that the characters vary, namely the number of leaves, leaf length, plant height to the base of the fruit, fruit bud size, flower stalk length, flower length, crown length, fruit weight and fruit pulp moisture content. Meanwhile, there are 12 uniform characters, namely leaf width, leaf thorn density, leaf thorn size, number of underground tillers, number of shoots on the stem, number of fruit buds, flower stalk diameter, petal length, fruit length, fruit eye size and fruit diameter.

The results of dendrogram analysis (Fig. 1) explain that the kinship relationship of 18 pineapple genotypes identified in Labuhan Batu Regency shows that several genotypes originate from the same area that is not always in the same group. The closest kinship relationship in pineapple plants that have been identified in Labuhan Batu Regency of North Sumatra was found in Central Panai District of Pasar Tiga Village in AN₃ and AN₄.

Pineapple plant morphological character: Observations on the observed parameters of the type of growth or plant crown were 3 variations: The type of growing upright, semi-erect

and wide. The semi-erect canopy is found in AN₅, AN₈, AN₉, AN₁₀, AN₁₁, AN₁₂, AN₁₃ and AN₁₈. Wide crown forms are found in AN₁, AN₂, AN₃, AN₄, AN₆, AN₇, AN₁₄, AN₁₅, AN₁₆ and AN₁₇. Observations on leaf morphological characters included several leaves, leaf length, leaf width, green colour on the top of the leaf, trichomes on the underside of the leaf, leaf spines, density of leaf spines, position of spines on leaf edges, the colour of leaf spines and size of leaf spines. Observations for the number of leaves parameters obtained that the highest number of leaves was found in AN₁₁, which was 43 strands and the lowest number was found in AN₃, which was 35 strands.

Observations on the morphological characters of flowers include flower stalk length, flower stalk diameter, flower tip colour, flower petal length and flower length. For the flower length parameters, the highest flower length was found in AN₃ and AN₄ with a length of 13.5 cm, while the lowest flower length was found in AN₁ with a length of 5.2 cm. It can be seen that the length of the lowest petal does not always affect the length of the fruit. It is proven that the length of the fruit of AN₁ is 18.1 cm. Observations on the morphological characters of the crown included the number of crowns, crown shape and crown size. In the crown size parameter, there are 3 variations, namely small, medium and large. Accessions that

Table 2: Phenotypic diversity (sem-laf) of pineapple plants based on comparative analysis of the diversity value with the standard deviation

Code samples	Number of leaf (sheet)	Long leaf (cm)	Wide leaf (cm)	Character	Morphologies		Plant: Height to the fruit base (cm)	Number of underground suckers	Number of aerial suckers on stem	Number of fruit shoots	Size of aerial suckers (cm)
AN ₁	36	85.7	5	Density leaf spine (mm)	Size leaf spine (mm)	2.2	40.2	2	2	0	0
AN ₂	40	83.5	3.4	3.5	2.4	41.3	41.3	2	2	0	0
AN ₃	35	75.7	4.1	3.8	2.6	35.7	35.7	0	4	0	0
AN ₄	37	72.5	4.1	3.9	2.1	35.7	35.7	0	4	1	3.8
AN ₅	41	90.2	3.8	3.3	2.1	38	38	1	1	1	3.5
AN ₆	37	94.6	3.1	3.2	2.3	33.5	33.5	1	2	2	5.4
AN ₇	41	93.5	4.1	0	0	55.7	55.7	0	1	0	0
AN ₈	41	74.6	4.7	0	0	55.7	55.7	0	1	1	15.5
AN ₉	41	85.7	4.1	0	0	55.7	55.7	0	1	1	14
AN ₁₀	37	84.6	3.5	4.1	2.5	32.4	32.4	2	2	0	0
AN ₁₁	43	90.2	3.4	3.1	2.7	34.6	34.6	2	2	0	0
AN ₁₂	39	73.5	4.1	3.7	2.9	33.5	33.5	0	4	0	0
AN ₁₃	38	81.3	3.7	3.2	3.2	35.7	35.7	0	3	1	17
AN ₁₄	39	69.1	4.1	4.5	3.4	25.7	25.7	0	3	2	7
AN ₁₅	36	80.2	3.8	4.3	3.6	30.2	30.2	0	4	0	0
AN ₁₆	37	81.3	3.4	4.4	2.8	31.3	31.3	0	4	1	7.3
AN ₁₇	38	77.9	4.4	4.1	2.2	32.5	32.5	0	2	0	0
AN ₁₈	39	90.2	3.7	4.8	2.4	33.5	33.5	0	2	1	4
σ ² p	4.839	57.040	0.234	2.408	1.198	80.110	80.110	0.732	1.320	0.486	33.227
Sdσ ² p	2.199	7.552	0.484	1.551	1.094	8.950	8.950	0.855	1.149	0.697	5.768
25Sdσ ² p	4.399	15	0.968	3.103	2.189	17.900	17.900	1.71	2.298	1.395	11.537
Criteria	Large	Large	Narrow	Narrow	Narrow	Large	Large	Narrow	Narrow	Narrow	Large

Data from pineapple characteristics research

Table 3: Phenotypic diversity (flowers and fruits) of pineapple plants is based on a comparative analysis of the diversity value with the standard deviation

Code	Flower stalk length (cm)	Flower stalk diameter (cm)	Flower petals length (cm)	Flower length (cm)	Characteristics		Morphological		Heavy fruit (grams)	Fruit eye size (cm)	Diameter size (cm)	Rate fruit flesh water (%)	Sweetness level of fruit flesh brix (%)
AN ₁	17.9	4.6	6.5	5.2	19.1	19.1	18.1	17.5	1.190	1.4	9.7	88	13
AN ₂	12.4	8.2	8.2	10.2	19.1	19.1	17.5	17.5	1.250	1.3	9.1	85	12
AN ₃	14.6	12.2	12.2	13.5	3.5	3.5	15.7	15.7	940	1.5	10.1	94	16
AN ₄	13.5	12.2	12.2	13.5	4.6	4.6	17.5	17.5	1.140	1.5	9.8	93	16
AN ₅	11.3	8.2	8.2	6.1	19.1	19.1	15.5	15.5	1.270	1.4	10.3	79	12
AN ₆	12.5	11.3	11.3	6.8	15.7	15.7	14.5	14.5	1.100	1.3	9.9	76	12
AN ₇	11.3	12.5	12.5	12.4	16.8	16.8	15.7	15.7	1.530	1.8	9.8	91	10
AN ₈	11.3	12.5	12.5	12.4	30.2	30.2	16.8	16.8	1.050	1.8	8.4	92	16
AN ₉	11.3	12.5	12.5	12.4	22.4	22.4	13.5	13.5	730	1.8	8	93	12
AN ₁₀	12.5	12.5	12.5	9.1	16.8	16.8	14.5	14.5	1.000	1.3	9.3	74	13
AN ₁₁	12.5	8.2	8.2	10.2	14.5	14.5	17.9	17.9	1.010	1.3	10.3	88	13
AN ₁₂	11.3	11.3	11.3	8.2	15.7	15.7	14.5	14.5	820	1.3	8.9	88	15
AN ₁₃	14.6	11.3	11.3	9.2	14.4	14.4	19.5	19.5	1.450	1.3	9.5	86	15
AN ₁₄	12.4	11.3	11.3	7.2	14.4	14.4	15.4	15.4	1.300	1.3	11	88	12
AN ₁₅	15.7	11.3	11.3	8.2	16.8	16.8	13.8	13.8	1.050	1.4	10	84	14
AN ₁₆	14.6	10.2	10.2	8.5	14.6	14.6	15.7	15.7	1.060	1.4	9.7	87	12
AN ₁₇	15.7	9.2	9.2	8.5	8.1	8.1	15.7	15.7	1.030	1.4	9.7	88	13
AN ₁₈	16.8	9.1	9.1	8.7	15.7	15.7	15.7	15.7	1.050	1.4	9.8	88	12
σ ² p	4.302	0.344	3.556	6.417	37.013	37.013	2.688	2.688	39993.79	0.031	0.495	31.477	3.000
Sdσ ² p	2.074	0.587	1.885	2.533	6.083	6.083	1.639	1.639	199.9845	0.178	0.703	5.610	1.733
25Sdσ ² p	4.148	1.174	3.771	5.066	12.167	12.167	3.279	3.279	399.969	0.357	1.407	11.220	3.467
Criteria	Large	Narrow	Narrow	Large	Large	Large	Narrow	Narrow	Large	Narrow	Narrow	Large	Narrow

Data from pineapple characteristics research

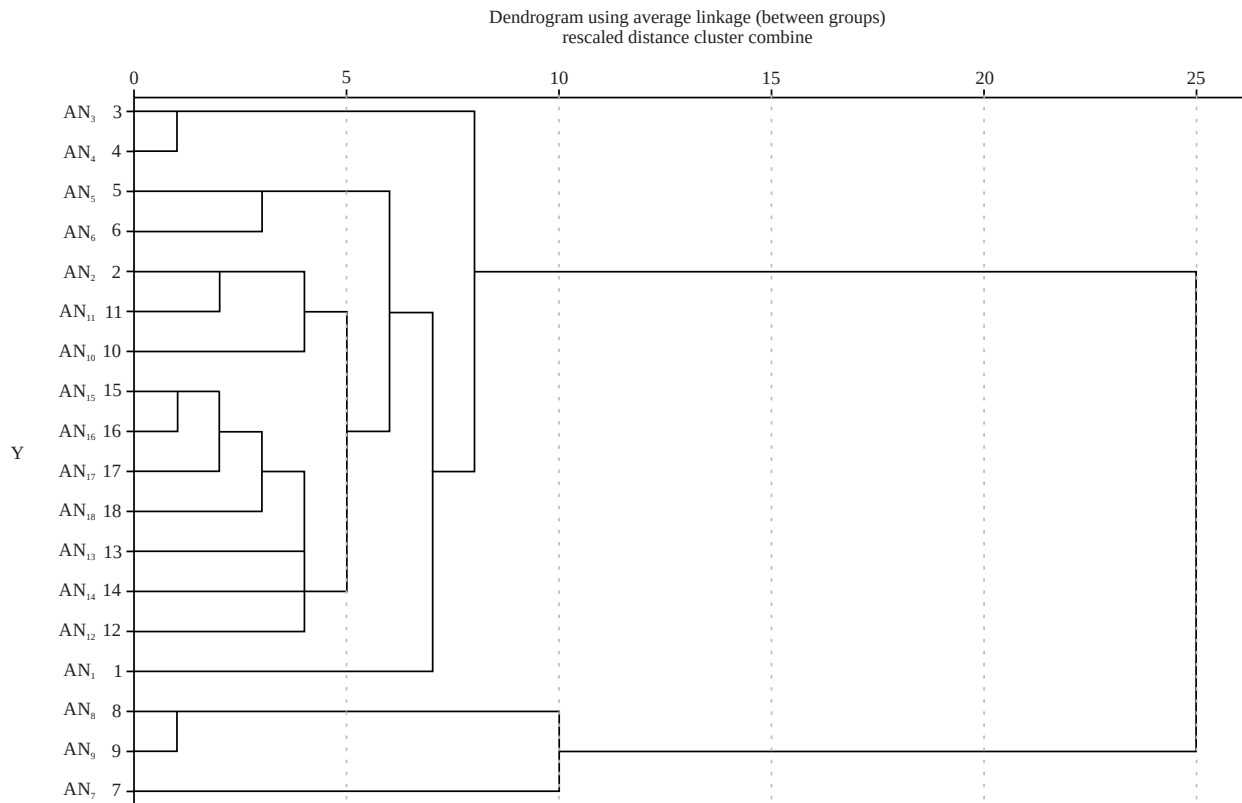


Fig. 1: Dendrogram of qualitative and quantitative character grouping of pineapple plants in Labuhan Batu Regency
Research results agglomerative hierarchical clustering-SPSS

have a small crown size are found in AN₃, AN₄ and AN₁₇. Medium crown sizes are available in AN₁, AN₂, AN₅, AN₆, AN₇, AN₁₀, AN₁₁, AN₁₂, AN₁₃, AN₁₄, AN₁₅, AN₁₆ and AN₁₈. The large crown size is found on the AN₈ and AN₉. With a small crown size in this study, it turned out to provide a sweet taste, soft texture and strong aroma.

Observations on the morphological character of the colour of ripe fruit include the colour of immature fruit, the ripe colour of the fruit. The ripe fruit colour parameter has 10 variations, namely green, silvery green, yellow with green spots, dull yellow, light yellow, golden yellow, dark yellow, reddish-orange, brown and others. Accessions with reddish-orange colour were found in AN₇, AN₈, AN₉ and the rest had light yellow ripe colour. Observations on fruit morphology included fruit shape, fruit length, fruit weight size, fruit eye size, fruit tip shape, fruit centre diameter. Observations on the parameters of fruit and weight have 3 variations, namely small, medium and large. Accessions with small sizes are available on AN₃, AN₉ and AN₁₂, accessions with medium sizes are on AN₁, AN₂, AN₄, AN₆, AN₈, AN₁₀, AN₁₁, AN₁₅, AN₁₆, AN₁₇, AN₁₈ and accessions with large sizes are available on AN₅, AN₇, AN₁₃ and AN₁₄.

Observations on the morphological characters of the fruit flesh include the colour of the flesh, the evenness of the colour of the flesh, the texture of the flesh, the hardness of the flesh, the aroma of the flesh, the moisture content of the flesh, the sweetness of the flesh. Some of the important characters in consumer preferences are the character of the texture of the fruit flesh and the aroma of the fruit flesh, the results of the study show that the character of the strong aroma and the texture of the soft/soft flesh of the fruit is found in accessions AN₃ and AN₄ which are located in Panai Tengah District, Pasar Tiga Village (Fig. 2a-h).

In (Fig. 2a-d) is AN₃ and (Fig. 2e-h) is AN₄. The pineapple in the picture is the featured pineapple in this study which has a sweet taste of 16% Brix. It is identified that the pineapple in the picture has characteristics close to the queen pineapple variety.

Pineapple plant relationships: The kinship relationship of morphological characters of 18 pineapple plant samples obtained from one village in Panai Tengah sub-district and one village in Bilah Hilir sub-district, Labuhan Batu district, shows a kinship relationship which can be seen in Table 4.

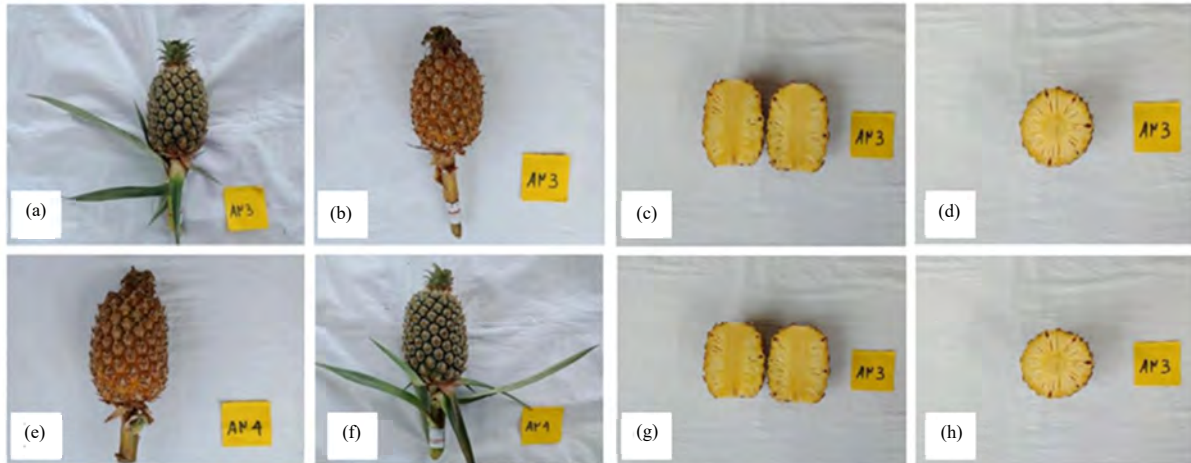


Fig. 2(a-h): Consumer preferences in Labuhan Batu Regency are available in access AN₃ and AN₄ except for pineapple large size characters

Photos from research results-SPSS

Table 4: Dissimilarity matrix sees pineapple plant kinship in the district of Panai Tengah and district of Bilah Hilir

Kinship		Dissimilarity value
3	4	11.410
15	16	13.070
8	9	13.541
2	11	21.970
15	17	22.029
15	18	23.124
5	6	24.652
13	15	28.942
13	14	31.219
2	10	32.297
12	13	33.642
2	12	37.863
2	5	44.227
1	2	51.468
1	3	55.936
7	8	64.744
1	7	155.789

Data from research results agglomerative hierarchical clustering-SPSS

Table 5: Grouping of 18 pineapple plant samples in Labuhan Batu Regency

Samples	Cluster 4	Cluster 3	Cluster 2
AN ₁	1	1	1
AN ₂	1	1	1
AN ₃	2	1	1
AN ₄	2	1	1
AN ₅	1	1	1
AN ₆	1	1	1
AN ₇	3	2	2
AN ₈	4	3	2
AN ₉	4	3	2
AN ₁₀	1	1	1
AN ₁₁	1	1	1
AN ₁₂	1	1	1
AN ₁₃	1	1	1
AN ₁₄	1	1	1
AN ₁₅	1	1	1
AN ₁₆	1	1	1
AN ₁₇	1	1	1
AN ₁₈	1	1	1

Data from research results agglomerative hierarchical clustering-SPSS

Table 6: Conjoint analysis results in 72 respondents (overall statistics) pineapple fruit in Labuhan Batu Regency

Utilities		Utility estimate	Std. Error
Taste	Sweet	0.789	0.033
	Sour	-0.848	0.039
	Sweet sour	0.058	0.039
Size	Small	-0.118	0.033
	Medium	-0.043	0.039
	Big	0.161	0.039
Aroma	Strong	0.160	0.033
	Medium	-0.016	0.039
	Unscented	-0.144	0.039
Color	Green	-0.016	0.033
	Yellow	-0.119	0.039
	Yellowish green	0.135	0.039
Texture	Small and delicate hollow	-0.111	0.033
	Big and rough hollow	-0.028	0.039
	Soft and smooth	0.139	0.039
Constant		3.095	0.031

Data from the results of conjoint analysis research-SPSS

Table 4, it can be said that the smaller the dissimilarity value between one variable and another, the closer the relationship between the variables (the higher), on the contrary, the greater the dissimilarity value, the higher the dissimilarity between variables. Thus, it can be seen that the lowest dissimilarity or closest kinship is found in AN₃ and AN₄, which is 11.410.

The results of the pineapple plant research in Labuhan Batu Regency obtained a kinship dendrogram which can be seen in Fig. 1 and groupings 2-3 and 4 in Table 5.

Consumer preferences on pineapple attributes and levels:

Consumer preferences in buying pineapples in Labuhan Batu

Regency can be seen from consumers who choose the attributes and levels of pineapples studied through questionnaires. Data from the questionnaire was standardized and then analyzed using IBM SPSS (Statistical Program for Social Science) version 20 with the conjoint analysis method. From the results of the conjoint analysis, it can be seen in Table 6.

DISCUSSION

The results of the identification of pineapple plants in Labuhan Batu Regency, North Sumatra that several samples have distinctive morphological characteristics and characters compared to other samples that can be used as sources of elders who have superior properties in pineapple plant propagation, namely the character of high levels of sweetness or soluble sugar in AN₃ and AN₄ (16% Brix) with characteristic cone/conical crown shape (Fig. 2). According to Witcombe *et al.*¹⁸ that the selection of elders is one of the crucial stages in the breeding process through crosses. With the discovery of these superior characters, it is hoped that pineapple plants can be propagated by combining superior characters to produce a new superior genotype of pineapple plants.

Accessions that have characters according to consumer preferences, namely the character of sweetness, are found in AN₃, AN₄ and AN₈. Large character sizes are found on the AN₇, AN₁₃ and AN₁₄. Strong aroma character and soft/soft texture are found in AN₃ and AN₄. The ripe yellowish-green/light yellow fruit is found in AN₁, AN₂, AN₃, AN₄, AN₅, AN₆, AN₁₀, AN₁₁, AN₁₂, AN₁₃, AN₁₄, AN₁₅, AN₁₆, AN₁₇ and AN₁₈. Based on the 3 groups of pineapple, namely 'smooth cayenne', 'red spanish' and 'queen' according to reports¹⁹, The authors suspect that the study sample on accessions AN₁, AN₂, AN₃, AN₄, AN₅, AN₆, AN₁₀, AN₁₁, AN₁₂, AN₁₃, AN₁₄, AN₁₅, AN₁₆, AN₁₇ and AN₁₈ belongs to the pineapple cultivar queen group. From the overall statistical utility values (overall statistics) for the attributes and the highest level of pineapple, the best combination of interest in pineapple according to consumer preferences is obtained, namely sweet taste, large size, strong aroma, smooth soft texture and yellowish-green colour.

From the overall statistical utility values for the attributes and the highest level of pineapple, the best combination of interest in pineapple according to consumer preferences is obtained, namely sweet taste, large size, strong aroma, smooth, soft texture and yellowish-green colour.

The reason respondents like sweet taste is that the dominant sweet taste gives the impression that the pineapple is ripe or ready to be consumed, fresh and increases purchase

interest. This corresponds to Viana *et al.*²⁰ related to sensory assessment of the quality of pineapples in Brazil that consumers want high sweetness, low acidity, soft texture and yellowish flesh colour. Next, according to Vita *et al.*²¹ regarding the purchase of citrus fruits in Italy, sweetness proved to be an important and main attribute for the respondents, revealing hidden prospects to increase the purchase frequency related to taste according to Simons *et al.*²² chemical groups identified related to various sensory attributes and consumer preferences in navel oranges in California, the sweet taste was found to be the 1st order followed by aroma and acid, that the main sensor drivers favoured by consumers, namely fructose, glucose and proline were among the most common compounds describe sweetness. Similar to Bartoszewski *et al.*²³ studied on the modification of tomato taste in transgenic, Fruit taste is an important component of fruit quality. Lowengart²⁴ research indicates that taste is the most important factor when choosing food products. It can be interpreted that the consideration of the taste of a product can be an indicator for someone to like or dislike a product. In this study, it was found that the taste that respondents preferred to pineapple was sweet.

Furthermore, for this reason, respondents chose pineapples with large sizes, namely pineapples with large sizes attracted the attention of respondents more than those with smaller sizes. Furthermore, according to most respondents' views, large pineapples indicate good plant maintenance to thrive and small fruit sizes indicate poor plant maintenance. Several studies on fruit weight are influenced by genetic factors and greatly influenced by population size/ha, spacing, where if the spacing used is tight, the smaller the size of the fruit produced. Valleser²⁵ but production/ha will increase with increasing plant population^{25,26}. Other than that, Liu and Liu²⁷ also stated that providing organic matter can increase fruit size. Another study also reported that the addition of Nitrogen (N), Phosphate (P) and Potassium (K) increased plant growth, fruit weight, fruit size and productivity^{28,29}. According to Ayinde *et al.*³⁰, Regarding consumer preferences for bananas in Kwara State, Nigeria, according to him, size is an important attribute after taste when purchasing fruit. At the same time, colour is considered a less important attribute.

Respondents chose pineapples with a strong aroma, according to most respondents' perceptions, pineapples with a strong aroma indicated the fruit was still fresh or freshly harvested. In contrast, fruits that did not have a strong aroma were considered wilted or not fresh anymore, thereby reducing the level of interest of the respondents. It is different if the pineapple is served in juice, according to Bocher *et al.*³¹

in Nairobi, Kenya, consumer preferences tend to prefer aroma over taste. The reason respondents chose pineapple fruit with a soft and smooth texture was to avoid discomfort on the tongue during and after consumption.

Respondents choose pineapple with yellowish-green colour is that the respondent has the perception that the pineapple is ready for direct consumption, according to previous studies^{30,32} that the colour of the fruit is considered by respondents to be a less important attribute and ranks last in the order of preference in the process of buying pineapples and bananas.

CONCLUSION

Based on the clustering of pineapple characteristics, the authors suspect that the study samples on accessions AN₁, AN₂, AN₃, AN₄, AN₅, AN₆, AN₁₀, AN₁₁, AN₁₂, AN₁₃, AN₁₄, AN₁₅, AN₁₆, AN₁₇ and AN₁₈ belong to the pineapple cultivar queen group. The combination of pineapple fruit that is a consumer preference is a fruit with a sweet taste, large size, strong aroma, soft and smooth texture and yellowish-green colour. Several accessions that have characters according to consumer preferences, namely the character of sweetness are found in AN₃, AN₄ and AN₈. Large character sizes are found on the AN₇, AN₁₃ and AN₁₄. Strong aroma character and soft/soft texture are found in AN₃ and AN₄. The ripe yellowish-green/light yellow fruit is found in AN₁, AN₂, AN₃, AN₄, AN₅, AN₆, AN₁₀, AN₁₁, AN₁₂, AN₁₃, AN₁₄, AN₁₅, AN₁₆, AN₁₇ and AN₁₈.

SIGNIFICANCE STATEMENT

This is the 1st research conducted by reporting that, identification of pineapple morphological characters in Labuhan Batu Regency, North Sumatra Province, Indonesia, obtained superior accessions, namely AN₃ and AN₄ located in Panai Tengah District, Pasar Tiga Village with a sweet taste character of 16% Brix, strong aroma, soft and smooth texture and yellowish-green/light yellow ripe colour. Furthermore, the combination of pineapple fruit that is a consumer preference in Labuhan Batu Regency, North Sumatra Province, is a fruit with a sweet taste, large size, strong aroma, soft and smooth texture and yellowish-green/light yellow colour.

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