



Quality and acceptance of pineapple as a result of potassic fertilization

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ABSTRACT: Brazil stands out as a major world producer of pineapple fruit (*Ananas comosus*), which is partly because the tropical climate is extremely favorable to the handling of pineapple. The State of Mato Grosso has a great production potential for this fruit, and currently ranks ninth in the ranking of national production. In order to be competitive in the market, it is necessary to offer fruit of excellent quality. The quality of a fruit brings together its sensory attributes, the nutritional value and the food safety it offers. The objective of the present work was to analyze the different doses of potassium fertilization in the organoleptic quality of the pineapple. The experimental design was a randomized block design in a 2x4 factorial scheme, with 8 treatments, consisting of 2 periods of fertilization, respectively (thirty and sixty days), and 4 doses of potassium (0, 5, 10 and 20 g plant⁻¹ of K₂O) in 3 repetitions. The results found in the tests performed on pineapples were not significant for the variables under study; however, they had good acceptability by consumers.

Keywords: *Ananas comosus*, sensory analysis, organoleptic quality.

Qualidade e aceitabilidade de abacaxi pérola em função da adubação potássica

RESUMO: O Brasil se destaca como um grande produtor mundial de frutos de abacaxi (*Ananas comosus*), isto em parte se deve ao clima tropical ser extremamente favorável à condução do abacaxizeiro. O estado de Mato Grosso possui um grande potencial de produção para essa fruta, e atualmente ocupa o nono lugar no ranking de produção nacional. Para se ter competitividade no mercado, é necessária a oferta de frutos de excelente qualidade. A qualidade de um fruto reúne seus atributos sensoriais, o valor nutritivo e a segurança alimentar que ele oferece. O objetivo do presente trabalho foi analisar as diferentes doses de adubação de potássio na qualidade organoléptica do fruto do abacaxizeiro. O delineamento experimental foi o de blocos ao acaso em esquema fatorial 2x4, com 8 tratamentos, constituídos respectivamente por 2 épocas de adubação (trinta e sessenta dias) e 4 doses de potássio (0, 5, 10 e 20 g planta⁻¹ de K₂O) em 3 repetições. Os resultados encontrados nos testes realizados em frutos de abacaxizeiro não foram significativos para as variáveis em estudo, no entanto apresentaram boa aceitabilidade junto aos consumidores.

Palavras-chave: *Ananas comosus*, análise sensorial, qualidade organoléptica.

1. INTRODUCTION

The pineapple (*Ananas comosus* L. Merrill) is a fruit originating in tropical and subtropical regions. It is consumed all over the world, both *in natura* and in the form of industrialized products (CARVALHO; BOTREL, 1996).

Of all the tropical fruits, pineapple is considered one of the most important, and its commercialization has been growing in the world market, mainly for its characteristics of flavor, aroma and color, appreciated in several regions (RAMOS, 2010).

The Brazilian pineapples are represented by the cultivars Smooth Cayenne and Pérola, and the cultivar Pérola is the most consumed, because its pulp is juicy and tasty. They have low levels of fiber and acidity, characteristics that make the fruit has

great potential of international commercialization (SANTANA et al., 2004; SOUTO et al., 2004).

According to IBGE (2015), in the State of Mato Grosso, in 2015, the planted area was 2,002 ha and the production reached 41,697 thousand fruit, generating an average yield of 23,922 fruit ha⁻¹. In the municipality of Alta Floresta, in the year 2015, the area planted was 10 ha, producing 200 thousand fruit, reaching an average of 20,000 fruit ha⁻¹.

The use of an appropriate fertilization is important for the crop to develop satisfactorily, reaching its maximum development and production. The nutrient requirement of the pineapple is high and varies according to the edaphoclimatic factors, management practices, cultivar used, density of planting and the form of commercialization, that is, destined to the consumption *in natura* or to the industry (SILVA, 2006).

The pineapple crop demands all nutrients in adequate doses; however, potassium (K) and nitrogen (N) are the most absorbed, of which N is related to fruit size and weight, whereas K affects mainly the physical and chemical quality of fruit (TEIXEIRA et al., 2002, GUARÇONI; VENTURA, 2011, CAETANO et al., 2013).

The quality of the fruit refers to the appearance, flavor and aroma, texture, nutritional value and safety of the products. Such attributes have varied importance, according to the interests of each segment of the marketing chain. The producers prioritize the appearance, that is, absence of defects, high resistance to diseases. Retailers and wholesalers have the appearance as the most important attribute, with emphasis on firmness and good storage capacity. Consumers, on the other hand, aim at the appearance and organoleptic characteristics (CHITARRA; CHITARRA, 2005).

The quality of the fruit is partly attributed to the physical characteristics responsible for the external appearance, among which the fruit size and shape and the color of the peel stand out. These characteristics will constitute the first factor of acceptability or not of the fruit by consumers. Another aspect is the intrinsic quality of the fruit that will give to the fruit and to the processed products the characteristic flavor and aroma, responsible for the final acceptance of the fruit in the consumer market (CUNHA et al., 1999).

Sensory analysis is a quick and judicious way of evaluating the quality of *in natura* products, since it is based on the use of the human sensory organs as measuring “tools” for the evaluation of physical and chemical attributes (MEILGAARD et al., 1999). It allows the complete description of the differences of the samples and guides the modification of characteristics of the studied product in order to meet the consumer’s requirements (JORDÃO, 2005). Through the sensorial evaluation it is possible to diagnose in a scientific and objective way the characteristics that influence the acceptability of the food by the consumer, by using the senses of a team composed of a group of people trained or not to analyze different organoleptic characteristics of foods (ABEA, 2015).

This work aimed to determine the quality of pineapple as a result of the supply of potassium applied in coverage, cultivated in the municipality of Alta Floresta - MT.

2. MATERIAL AND METHODS

The experiment was installed and conducted in the experimental area of a rural property in the municipality of Alta Floresta, located on Highway MT-208, located at 09° 55’ 12” South latitude, 56° 13’ 36” West longitude, with an altitude of 290 meters. The region has average annual rainfall of 2,700 mm and annual average temperature of 24° C. The soil of the site was classified as typical Dystrophic Red-Yellow Latosol (EMBRAPA, 2013).

The experimental design was a randomized block design in the 4x2 factorial scheme, with 8 treatments consisting of 4 doses of potassium (0, 5, 10 and 20 g plant⁻¹ of KCl) in 2 application intervals (30 or 60 days), with 3 repetitions.

A ‘cub’ seedling of the cultivar Pérola was used, with an average weight of 180 g. The seedlings were acquired from a rural producer in the municipality itself. Soon after, these were cleaned and the healing of these was performed for seven days. At the time of planting, the seedlings were treated with benomyl

fungicide and were distributed in the field, and soon after they were placed in pits under slight manual pressures.

Nitrogen was applied to the planting in a single dose of 20 g plant⁻¹. For the doses of potassium, the applications were carried out in different periods: every 30 days and every 60 days. Urea was used as a nitrogen source, and potassium chloride was used as a potassium source. Phytosanitary treatments were carried out where necessary and according to the recommendations for crop.

Of the fruit harvested, 30 were randomly selected from the useful area of each plot to determine the following variables: Total Soluble Solids (SS - °Brix) and Titratable Total Acidity (TA).

In order to determine the SS content, an N-type portable manual analogue refractometer with scale in degrees °Brix and divisions of at least 0.2° Brix was used. For each sample, the juice was extracted through the opening of a small hole in the median region of each fruit and two drops were dripped in the refractometer, for reading (GOMES, 2010).

In order to determine the TA, the titration process was used with an electronic bench titrator model HI84102® Hanna Instruments, in which 2 mL of juice was diluted in 50 mL of distilled water, following the methodology adopted by Gomes (2010). This solution was titrated on the equipment with the addition of 0.5 molar NaOH (20 g L⁻¹ of NaOH).

The sensorial analysis was carried out in the Laboratory of CETAM (Technological Center of Southern Amazonia) of UNEMAT, by using the Acceptance Index (AI) through the use of a 9-point hedonic scale (I liked it very much = 1 to I greatly disliked it = 9) for the attributes color, flavor, aroma, texture, sweetness and overall acceptance, following the procedure described by Sanches (2010). The evaluation was performed by 68 untrained testers who were later asked about the intention to buy, using a 6-point structured scale, in which 6 represent “I would certainly buy” and 1 “I certainly would not buy”.

Each tester received two coded samples corresponding to four different doses of fertilization. The fruit were cut into cubes of approximately 2 cm and packed in disposable plastic containers for tasting and served together with the questions form to the tasters.

The data were submitted to analysis of variance, and the means were compared by the Tukey test at 10% of probability.

3. RESULTS AND DISCUSSION

Regarding the acceptance of the pineapple samples, according to their sensorial characteristics perceived by the tasting, the graphical representation of the acceptance index (A.I.) is shown in Figure 1.

For this variable, it is verified that the excessive fertilization of the plants promoted fruit production whose quality was refuted by the tasters, regardless of the interval (30 or 60 days). A higher acceptance rate was verified with fertilization of 10 grams in both intervals, indicating that the species can absorb the nutrient and convert it into substances that, in the fruit, when tasted, show a superior acceptance. According to Oliveira (2010), 70% acceptance rate is the minimum necessary to be considered accepted by consumers.

Similar results were also observed in a study conducted by Sanches (2010), in which the sensory profile of the pineapple (Cultivar Pérola) samples, also produced as a result of potassium fertilization and planting at different times, found that the

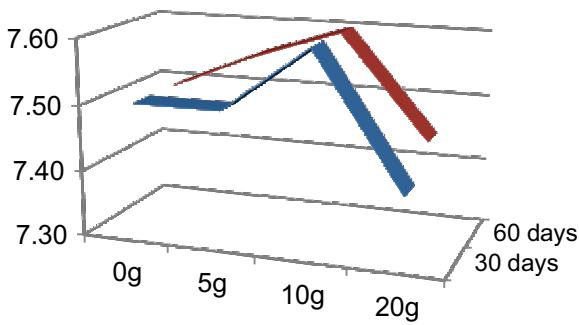


Figure 1. Graphic representation of the acceptability index (A.I.) of the scores obtained for each fertilization interval. Hedonic scale notes ranged from: “I liked it very much” = 1 to “I greatly disliked it” = 9.

Figura 1. Representação gráfica índice de aceitabilidade (I.A.) das notas obtidas para cada intervalo de adubação. Notas da escala hedônica variaram entre: “gostei muitíssimo” = 1 a “desgostei muitíssimo” = 9.

highest averages of untrained tasters were concentrated in the first planting season (8 months), but the percentage of both seasons also remained higher than 70%.

As for the attribute color, the evaluation performed by the tasters is shown in Figure 2.

Regarding the attribute color, the fruit that obtained the best results were those whose plants received 20 grams of fertilization, every 30 days. In the 60-day interval, there was a tendency for relatively similar responses, but in all fertilizations, the acceptance scores remained between 1 and 3, characterized by a great acceptance of the product.

By means of this analysis, it was observed that the application of potassium in smaller intervals differed from the control in which there was no supply of the nutrient. These results are similar to those reported by Teixeira et al. (2002), who verified better results both in the quantity and in the quality of the same pineapple produced (Pérola) with divided potassium fertilization.

The appearance is very important because it influences the final decision of the consumer to buy or not the fruit. It was verified that the color of the fruit varying for the yellow tonality was the one that indicated greater acceptance, when the amount of potassium was greater in smaller intervals.

In fairs and even supermarkets, it is common to have samples of various products for tasting, at a counter, in shelves and with sales promoters. This practice is not very common for the pineapple; however, the yellowish coloration is the preferred one of the consumers and the whiteness is usually indicative of high acidity (SANCHES, 2010). The results observed in the present study reinforce this assertion, indicating that the consumer is more interested in fruit whose coloration is not totally white, because they expect that the product has a color that characterizes it as mature and avoid consuming it when it is different from the expected in color or intensity (OLIVEIRA, 2010).

As for the flavor, the scores obtained are presented in Figure 3. The fruit that stood out were those that received fertilization of 5 grams every 60 days, whereas in the 30-day interval, the same amount of fertilization presented lower values.

Although the most accepted color was the one with fertilization of 20 grams at a 30-day interval, this did not

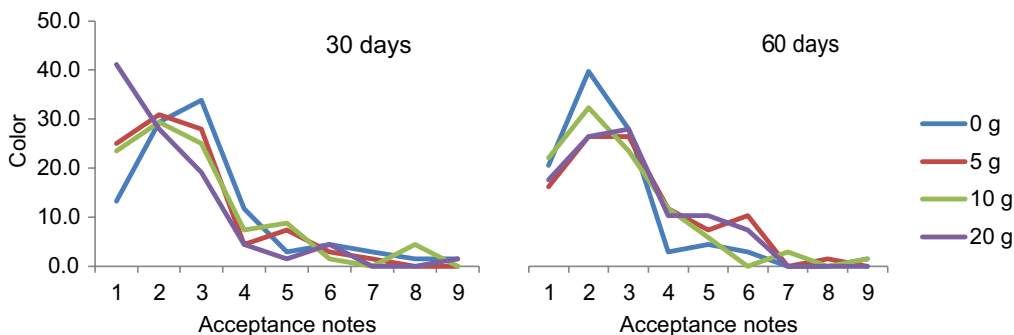


Figure 2. Graphic representation of the sensory profile of color of pineapple samples submitted to different doses and periods of potassium fertilization.

Figura 2. Representação gráfica do perfil sensorial de cor das amostras de abacaxi submetidas a diferentes doses e épocas de adubação potássica.

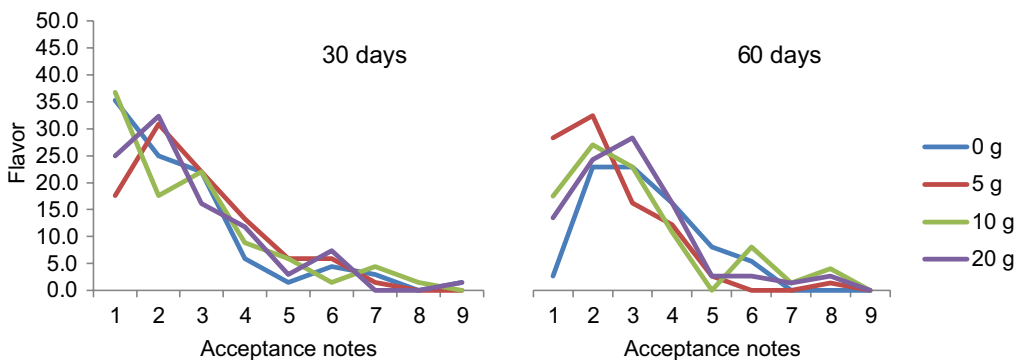


Figure 3. Graphic representation of the sensory profile of flavor of pineapple samples submitted to different doses and periods of potassium fertilization.

Figura 3. Representação gráfica do perfil sensorial de sabor das amostras de abacaxi submetidas a diferentes doses e épocas de adubação potássica.

influence the evaluation of the flavor of the fruit. The flavor is considered as a mixed but unitary experience of olfactory, taste and tactile sensations perceived during the tasting. Thus, the best known perception involves the four primary tastes: sweet, salty, sour and bitter (OLIVEIRA, 2010). In the present study, it was verified that for pineapple, the acid and sweet sensations are the ones that are most emphasized. Based mainly on these two primary tastes, the evaluators reported in their evaluations that for 30-day intervals, the flavor is more intense in the fruit produced in the treatments that received 0 and 10 grams of potassium, and that for 60-day intervals, 5 grams of potassium was the dose that provided the best flavor in the fruit of pineapple.

Possibly, the set of attributes that compose the flavor of the fruit has been highlighted under conditions in which fertilization has occurred in sufficient time for the metabolization of the nutrient and conversion to sugars and aromas, as it was the case of fertilization of 5 grams every 60 days and 10 grams every 30 days. Similar results were also observed by Sanches (2010), who reported a higher percentage of acceptance when the fruit were from plants grown since November and fertilized with up to 6 grams of potassium. The absence of fertilization may indicate that the fruit underwent nutritional stress and under these conditions the plant sought to provide the fruit with a load of metabolites that culminated in the balance of olfactory and taste sensations.

As for the aroma, the scores are presented in Figure 4. For this sensorial attribute, even though there were no expressive results, the values that stood out were in the treatment in which there was fertilization of 10 grams at every 60 days. Regarding

fertilization every 30 days, there was not a big difference between the treatments, and all of them were approved for consumption, since the great majority of the scores varied between 2 and 3.

Aroma is the organoleptic property that is perceptible by the olfactory organ when certain volatile substances are aspirated, being subject to variables, such as fatigue and adaptation (SANCHES, 2010). Thus, in the present study, the inhalation of volatile substances may have promoted the sensation of acceptance in all treatments. So, other attributes were necessary so that the treatments could be differentiated by the tasters. It is possible that this variable is not safe for indication of acceptance of the pineapple fruit.

According to Oliveira (2010), while a food is chewed, its characteristic aroma is released into the mouth, passing to the nostrils through the nasopharynx to the olfactory epithelium and, as occurred in treatments with fertilization at 30-day intervals, the sensations were perceived similarly by the evaluators.

For the variable texture, higher percentages of score 1 (I liked it very much) were observed in the larger doses (10 and 20 g) at intervals of 30 days (Figure 5). The fruit of pineapples fertilized every sixty days presented very similar variation among the treatments, indicating the difficulty of the evaluators in separating the different dosages of the fertilizer when applied in these intervals.

This variable is barely perceptible in the fruit of the pineapple. Possibly, this difficulty may have provided the results obtained for this factor, since the texture is the set of all the rheological and structural properties of a food by the mechanical and tactile receptors and eventually by the visual

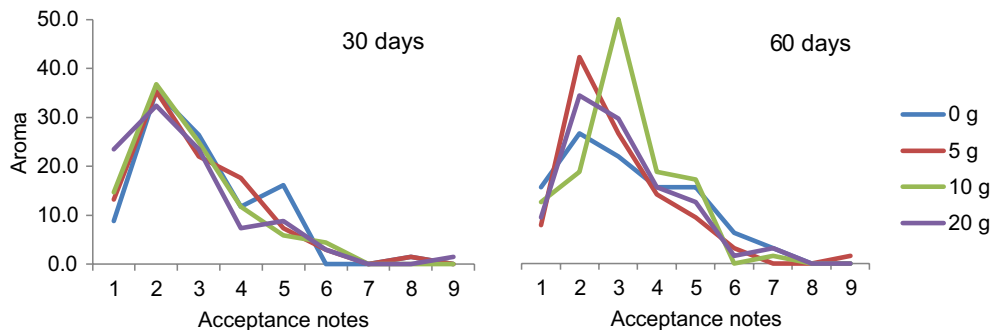


Figure 4. Graphic representation of the sensory profile of aroma of pineapple samples submitted to different doses and periods of potassium fertilization.

Figura 4. Representação gráfica do perfil sensorial de aroma das amostras de abacaxi submetidas a diferentes doses e épocas de adubação potássica.

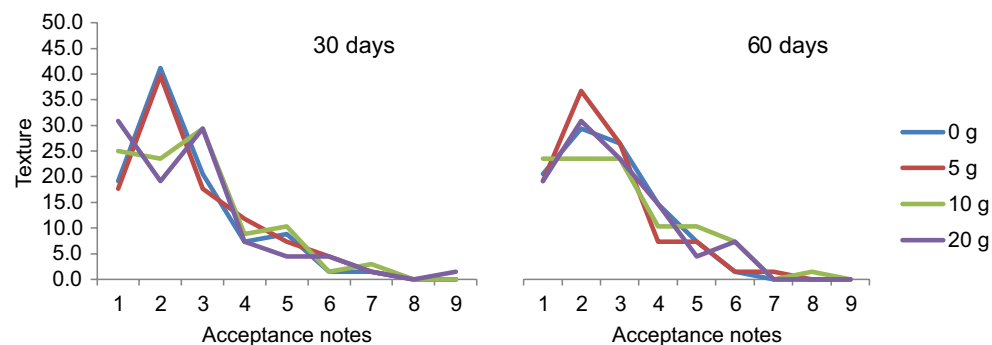


Figure 5. Graphic representation of the sensory profile of texture of pineapple samples submitted to different doses and periods of potassium fertilization.

Figura 5. Representação gráfica do perfil sensorial de textura das amostras de abacaxi submetidas a diferentes doses e épocas de adubação potássica.

and auditory receptors (SANCHES, 2010). Although texture is an important physical attribute of the food, it was not so much observed by the tactile perceptions of tasters and consequently in their answers.

For the variable sweetness, as well as the texture, the fruit with fertilizations with 60-days intervals were superior to those with fertilization of 30-days intervals (Figure 6).

Sweetness is given by the Brix/Acidity ratio. The content of solids soluble in pineapples should be above 12° Brix and the acidity, below 1% to be considered suitable for consumption (CUNHA, 1999).

Similar values were found in the present study regarding Brix (Table 1). As for the acidity, these varied between 3.06 and 4.74%, being superior to those suggested by the author. OLIVEIRA (2010) states that the fruit can have a high content of soluble solids and still have an acid taste. The acidity above 1% makes the acid taste predominates over the sweet. This fact was observed in the present study.

It is noticed that, although the attribute color indicates a tendency of greater acceptance of fruit whose fertilization was carried out at intervals of thirty days, the other attributes provide information on a better acceptance of the pineapples in which the fertilization was carried out with intervals of sixty days.

As for the overall acceptance, that is, the evaluation of all attributes analyzed, such as: color, flavor, aroma, texture, sweetness, gathered in a single score, characterizing its receptivity for the consumer (OLIVEIRA, 2010), fertilizations at 30-day intervals with 10 and 20g of potassium were the ones that allowed the tasters to assign the highest scores (Figure 7).

The greater acceptance of samples taken from fruit allows reinforcing the recommendation on the best season of

Table 1. Averages of Brix and Acidity of pineapples grown as a result of increasing doses of potassium.

Tabela 1. Médias das variáveis Brix e Acidez de frutos de abacaxi cultivados em função de doses crescentes de potássio.

FV	Brix	Acidity
Time (days)		
30	14.13 a	4.74 a
60	15.62 a	3.06 b
Value F	1.215ns	9.094*
Dose (g)		
0	13.98 a	4.35 a
5	14.39 a	4.07 a
10	13.98 a	3.81 a
20	17.15 a	3.37 a
Value F	1.284ns	0.685ns
Times * Dose	0.526ns	0.177ns
CV	22.19	16.00

ns: non-significant for the F test; *: significant at 5% of probability by the Tukey test.

fertilization of pineapple, aiming the commercialization for *in natura* consumption. And, in this study, the 30-day interval of 10 or 20 g was the treatment that corresponded to the best conditions of fruit production with great acceptability by consumers.

Regarding the buy intention of the fruit analyzed (Figure 8), 47.06% of the testers would certainly buy it and 39.71% would probably buy the product and only 7.35% would maybe buy it or maybe not. 2.94% had doubts about whether they would buy the fruit they tasted, and 2.94% would probably not buy the product. These results demonstrate the great acceptance of the fruit, independently of the fertilization and the interval in which it was accomplished.

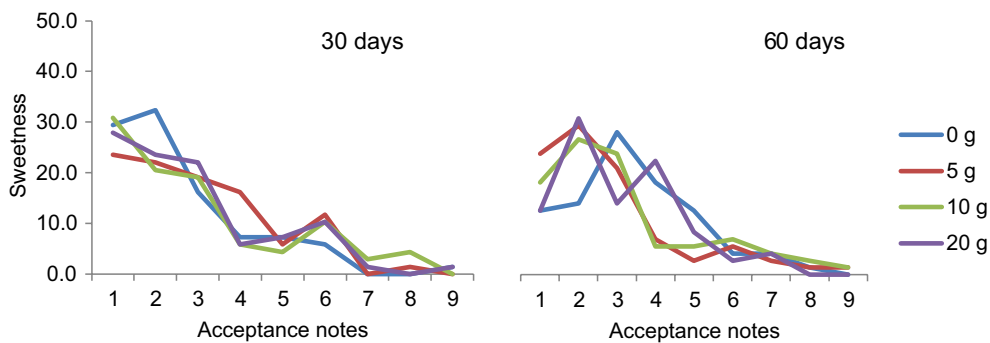


Figure 6. Graphic representation of the sensory profile of sweetness of pineapple samples submitted to different doses and periods of potassium fertilization.

Figura 6. Representação gráfica do perfil sensorial de doçura das amostras de abacaxi submetidas a diferentes doses e épocas de adubação potássica.

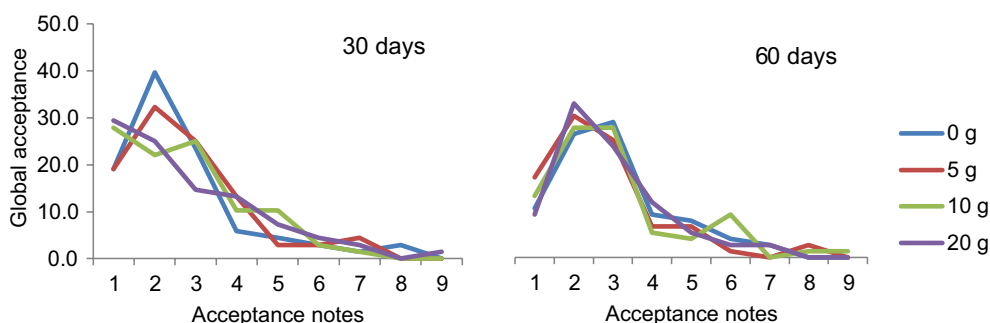


Figure 7. Graphic representation of the sensory profile of overall acceptance of pineapple samples submitted to different doses and periods of potassium fertilization.

Figura 7. Representação gráfica do perfil sensorial de aceitação global das amostras de abacaxi submetidas a diferentes doses e épocas de adubação potássica.

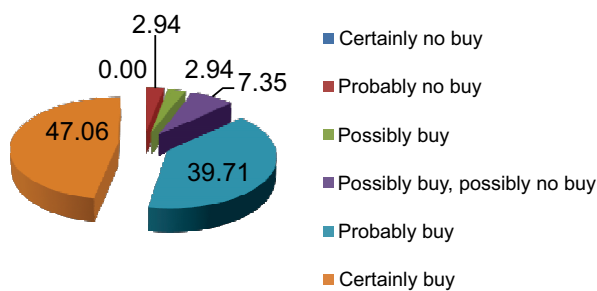


Figure 8. Graphical representation of the purchase intention of pineapple samples submitted to different doses and periods of potassium fertilization.

Figura 8. Representação gráfica da intenção de compra das amostras de abacaxi submetidas a diferentes doses e épocas de adubação potássica.

The pineapple fruit of the cultivar Pérola are the most cultivated throughout Brazil, for purposes of *in natura* consumption. The results demonstrate that the cultivation conditions in the region of Alta Floresta-MT are adequate for its production.

Despite the variation of results in the sensory analysis of pineapples, it is observed that the application of 0 to 20 grams of potassium in larger intervals were those that provided greater acceptance.

There are several factors that can influence the acceptance and subsequent acquisition of a fruit (SANCHES, 2010). These factors may be related to cultural aspects such as consumption habits of each individual; social factors such as behavior of each member, the influence on the behavior of others; personal factors such as age, occupation, economic situation and lifestyle, and finally psychological factors that provide motivation to meet a need that arouses desire (RODRIGUES; JUPI, 2004; GOMES, 2010). All these elements are feasible of change and influence in the final decision. Thus, the results of this work can be used as a tool for both the productive aspect and for the development of supply and marketing strategies in certain local consumer markets.

4. CONCLUSIONS

Under the conditions of the present study, it can be concluded that:

Potassium fertilization of 10 to 20 grams in pineapple of the cultivar Pérola at intervals of 60 days favors the sensorial attributes: texture, aroma, flavor and global acceptance, allowing greater acceptance and purchase interest in the fruit.

5. ACKNOWLEDGEMENTS

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