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FOOD TECHNOLOGY

Expandable polyethylene bag can improve fruit quality of pineapple cv. 'MD-2'

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ABSTRACT: *Paper and plastic bags have been mainly used in fruit bagging of pineapple production. However, they are often discarded as agricultural wastes after harvest of pineapple fruit and threaten environment. In this study, effects of white non-woven fabric bag, expandable polyethylene bag, black plastic bag and kraft paper bag on fruit quality of pineapple cv. 'MD-2' were investigated. Results showed that fruits with fruit bagging showed no sunburn. When expandable polyethylene bag was used, fruits of pineapple cv. 'MD-2' showed better external qualities, nutrition qualities and texture properties. Expandable polyethylene bag made of degradable and recyclable materials could be recommended as a promising practice to reduce agricultural waste in pineapple production.*
Key words: *pineapple, fruit bagging, expandable polyethylene bag, texture properties, agricultural waste.*

Saco de polietileno expansível pode melhorar a qualidade do abacaxi cv. 'MD-2'

RESUMO: *Sacos de papel e plástico têm sido usados principalmente no ensacamento de frutas na produção de abacaxi. No entanto, eles são frequentemente descartados como resíduos agrícolas, após a colheita da fruta do abacaxi, e ameaçam o meio ambiente. Neste estudo, os efeitos da sacola de tecido, não tecido branco, sacola de polietileno expansível, sacola plástica preta e sacola de papel artesanal na qualidade do fruto do abacaxi cv. 'MD-2' foram investigados. Os resultados mostraram que as frutas ensacadas não apresentaram queimaduras solares. Quando foi utilizada a bolsa de polietileno expansível, as frutas de abacaxi cv. 'MD-2' mostraram melhores qualidades externas, qualidades nutricionais e propriedades de textura. O saco de polietileno expansível feito de materiais degradáveis e recicláveis pode ser recomendado como uma prática promissora para reduzir o desperdício agrícola na produção de abacaxi.*
Palavras-chave: *abacaxi, ensacamento de frutas, saco de polietileno expansível, propriedades de textura, resíduos agrícolas.*

INTRODUCTION

Pineapple is one of the most important tropical fruits in the world. It is mainly cultivated in areas between north and south tropics of cancer. In these areas where there are excess light irradiance (visible and ultraviolet light), the sunburn of pineapple fruit often occur and sometimes sunburn rate reached to over 50% (MUNNÉ-BOSCH & VINCENT, 2019; ZHANG et al., 2009). Sunburn is a physiological disorder of pineapple fruit. Symptom includes bleached, yellow-white fruit skin, turning pale grey or brown upon damage to the tissue underneath. It will influence fruit quality of fruit and then lead to economic loss (ZHANG et al., 2009; RABIE & MBATHA, 2016).

To protect pineapple fruit from sunburn, traditionally many farmers tie pineapple leaves to wrap young pineapple fruits or use rice straw to cover fruit. These measures are less-costly, but they result in some disadvantages: leaves wrapping fruits grow poorly and rice straw could be the suitable place for some diseases and pests. Recently, some new measures were proposed including shading (KISHORE et al., 2021; ZHAO et al., 2020a,b,c), application of liquid sun shield film (RABIE & MBATHA, 2016), application of crop protectant (BELL et al., 2006), and fruit bagging (LU et al., 2010, 2011; PRABHA et al., 2018; ZHAO et al., 2019). Shading needs a shading net and intercropping system. The cost of shading net covering the whole field is high and intercropping system is not feasible because it could

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produce interaction between pineapple and other crops. Liquid sun shield film and crop protectants are expensive because commercial companies develop them. Compared to shading and application of liquid sun shield film and crop protectant, fruit bagging has great advantages because of its relatively low cost and less negative effects. It can not only protect fruits but also affect fruit growth and quality, so it has been widely used in many fruits (SHARMA et al., 2014; BUTHELEZI et al., 2020).

LU et al. (2010) studied the effects of fruit bagging time on growth and quality of pineapple cv. 'Smooth Cayenne' using a one-layer white paper bag. Subsequently, LU et al. (2011) believed that one-layer white paper bag had better effect on fruit growth and quality of pineapple cv. 'Smooth Cayenne' than two-layer yellow-out-dark-in paper. PRABHA et al. (2018) thought that paper bag was better option than jute bag, transparent polythene bag and black polythene bag for fruit bagging of pineapple cv. 'Mauritius'. Results of ZHAO et al. (2019) indicated that bagging with black plastic bags was beneficial to increase the weight per fruit and edible rate of pineapple, improve the soluble solids, soluble sugar and vitamin C, and reduce the total acidity of pineapple fruit. Paper and plastic bags have been mainly used in practical pineapple production. However, they are often discarded as agricultural wastes after the harvest of pineapple fruit (YAN et al., 2019; KUMAR et al., 2020). It will threaten the environment because paper is made of wood and its production could bring about environmental pollution and plastic bag is hard to be degraded. To solve this problem, white non-woven fabric bag and expandable polyethylene bag (EPE bag) are made of degradable and recyclable materials (YUAN et al., 2013; WANG, 2012).

Pineapple cv. 'MD-2' is a hybrid variety developed in the breeding program of the of the now-defunct pineapple research institute in Hawaii. It has a high disease and pest resistance, high yield, and outstanding fruit quality with golden external colour, golden flesh colour, higher vitamin C content, slightly higher soluble solids content than 'Smooth Cayenne', considerably lower acidity, and exceptional post-harvest shelf life (BARTHOLOMEW, 2009). So it has become a popular pineapple cultivar worldwide. The objective of this study was to investigate the effects of the white non-woven fabric bag, EPE bag, black plastic bag, and kraft paper bag on fruit quality of pineapple cv. 'MD-2' in order to control sunburn and reduce the negative effect on the environment.

MATERIALS AND METHODS

Plant material and growth conditions

The experiment was conducted at the Eighth Branch of Jinghong Farm, Gasa Town, Jinghong City, Yunnan Province, China. The experimental field is situated at a latitude of about 21.93°N and longitude of 100.73°E with altitude 562-599 m. The soil type is acid latosol at pH value of 6.0. The field has total solar radiation per year of 5487.27-5652.60 MJ / m^2, sunshine duration per year of 1820.1-2179.1 hours, and a clear distinction between wet and dry seasons. In dry season from November to April next year, there are less rainfall and stronger sunshine.

Seedlings of pineapple cv. 'MD-2' with plant height of 30 cm were planted with space following a 65×30 cm pattern. It has two fruiting time in two years. Fruit qualities in the first fruiting time were better than in the second fruiting time. So, we used fruits in the first fruiting time as materials.

Fruit bagging

Fruit bagging was conducted on the 40th day after flower fading and continued until harvest according to LU et al. (2010). Before bagging, 70% thiophanate methyl diluted 1000 times was sprayed on the surface of pineapple fruits. Four treatments with no fruit bagging as control were set using a completely random design. There were four types of bags as four treats: black plastic bag, kraft paper bag, white no-woven fabric bag, and EPE bag (Figure 1). Yongxin Fruit Bag Factory (Anhui, China) manufactured these four bags with a size of 25 × 36 cm. Each treat was replicated 4 times with 10 fruits as a replication.

Sunburn and fruit quality measurements

External fruit quality parameters included fruit sunburn rate (%), fruit weight without crown (g), pulp weight (g), longitudinal diameter (cm), transverse diameter (cm), fruit shape index, ratio of edible parts, and number of fruit eyes according to Lu et al. (2010, 2011). Fruit sunburn rate (%) was measured based on the number of sunburnt fruit to the fruits of each treatment.

Nutrition qualities included carotenoid content (%), total soluble solid content (%), Vitamin C content (%), titratable acidity content (%) and soluble sugar content (mg/g). Carotenoid content was measured by acetone extraction; total soluble solids content were measured by hand refractometer (ATAGO RX-5000); Vitamin C content was measured using 2, 6-dichloroindophenol titration method; titratable acidity content was measured using neutralization titration method; soluble sugar content was measured by the DNS (3, 5-dinitrosalicylic acid) reagent method.

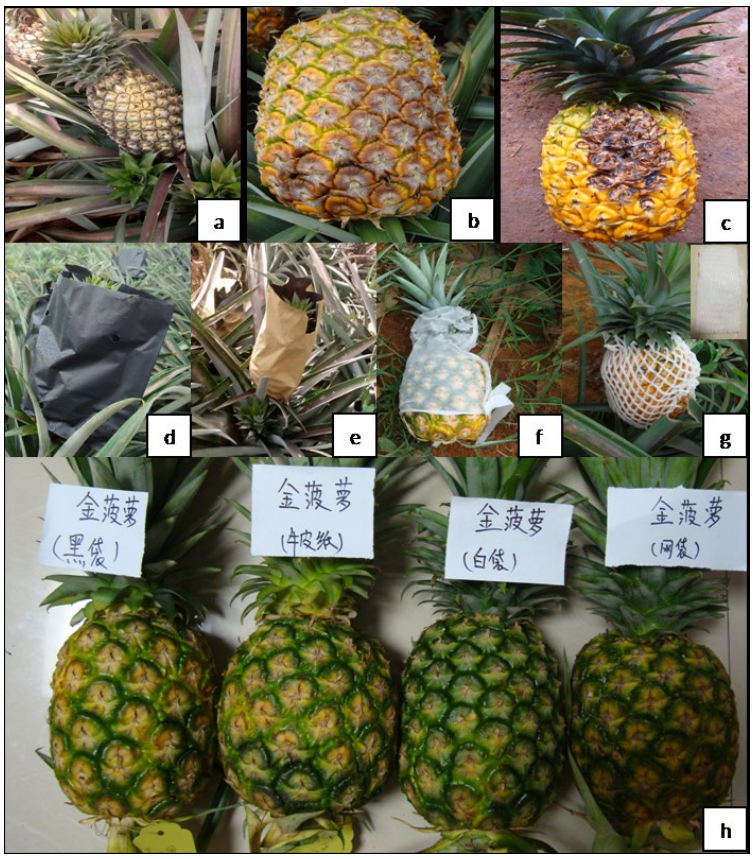

Figure 1 - Fruit sunburn with no fruit bagging as control (a: Bleached skin; b: yellow-white fruit skin; c: brown fruit skin); Fruits with fruit bagging (a: black plastic bag; b: kraft paper bag; c: white no-woven fabric bag; d: EPE bag); Fruit sunburn with no fruit bagging as control (Left: Bleached skin; Middle: yellow-white fruit skin; Right: brown fruit skin.

Texture properties included hardness, cohesiveness, springiness and chewiness. They were measured by TMS-Pro Texture analyzer. The plunger height was 45 cm, and the speed was 1.0 mm/s. A two-bite cycle was employed. The time between the two strokes was 1.5 s.

Statistical analysis

Data were subjected to analysis of variance (ANOVA). Mean comparisons were performed using the LSD test ($P < 0.05$). All analyses were performed using SPSS 20.0.

RESULTS

Fruit bagging had a significant effect on fruit sunburn rate (Table 1). Fruits with fruit bagging showed no sunburn (Figure 1) while fruits without fruit bagging showed sunburn (Figure 1).

Fruit bagging significantly decreased fruit weight without crown, pulp weight, longitudinal diameter, transverse diameter, fruit shape index, and the ratio of edible parts. Four fruit bags had no significant effects on external fruit quality (Table 1).

Table 2 showed the effects of different fruit bags on the nutrition quality of pineapple cv. 'MD-2'. Fruit bagging significantly decreased carotenoid content. White no-woven fabric bag produced the second largest carotenoid content and there was no significant difference in carotenoid content among white no-woven fabric bag, black plastic bag and EPE bag. Fruit bagging significantly decreased total soluble solids content. EPE bag produced the second largest total soluble solid content and there was no

Table 1 - Effects of different fruit bags on external fruit quality of pineapple cv. 'MD-2'.

Treatment	Fruit sunburn rate (%)	Fruit weight without crown (g)	Pulp weight (g)	Longitudinal diameter (cm)	Transverse diameter (cm)	Fruit shape index	Ratio of edible parts	Number of fruit eyes
EPE bag	0±0.00 b	992.86 ± 21.27 b	702.75 ± 12.95 b	13.14 ± 0.09 b	11.42 ± 0.28 b	1.15 ± 0.02 b	0.71± 0.02 b	74.64± 4.68 b
White no-woven fabric bag	0±0.00 b	1073.19 ± 127.13 b	764.42 ± 100.22 b	13.29 ± 0.30 b	11.59 ± 0.53 b	1.15 ± 0.03 b	0.71± 0.01 b	78.75± 6.85 ab
Black plastic bag	0±0.00 b	1093.06 ± 137.83 b	787.22 ± 108.74 b	13.42 ± 0.62 b	11.79 ± 0.34 b	1.14 ± 0.02 b	0.72± 0.01 b	79.89± 6.69 ab
Kraft paper bag	0±0.00 b	1062.89 ± 151.50 b	761.50 ± 128.42 b	13.36 ± 0.64 b	11.71 ± 0.37 b	1.14 ± 0.03 b	0.72± 0.02 b	77.39± 5.00 b
Control	100±0.00 a	1766.00 ± 89.08 a	1374.33 ± 53.78 a	15.97 ± 0.25 a	13.37 ± 0.32 a	1.19 ± 0.02 a	0.78± 0.01 a	91.33± 9.50 a

Note: Different lower-case letters indicate significant differences between treatments at $P < 0.05$. Values are means ± SE.

significant difference in total soluble solid content among white no-woven fabric bag, EPE bag and kraft paper bag. Fruit bagging significantly increased Vitamin C content. Black plastic bag and kraft paper bag produced maximum vitamin C content and there was no significant difference on vitamin C content among EPE bag, black plastic bag, and kraft paper. Fruit bagging decreased titratable acidity content. Black plastic bag produced maximum titratable acidity content while EPE bag produced minimum titratable acidity content. Fruit bagging decreased soluble sugar content. There was no significant difference in soluble sugar content among four different fruit bags.

According to Table 3, when EPE bag was used, fruit hardness was significantly highest while fruit hardness was significantly lowest when white non-woven fabric bag was used. There was no significant difference in hardness among black plastic bag, kraft paper bags and the control. Fruit bagging had no significant effect on cohesiveness. White non-woven fabric bags could result in the lowest springiness and there was no significant difference in springiness among the four fruit bags. EPE bag could result in significantly highest chewiness while chewiness was significantly lowest when white non-woven fabric bag was used. There was no significant difference in chewiness among black plastic bags, kraft bags and the control.

DISCUSSION

In our study, no fruit sunburn was reported when fruit bagging was applied. It is accordant with the results of LU et al. (2010, 2011) reporting that bagged fruit of pineapple cv. 'Smooth Cayenne'

Table 2 - Effects of different fruit bags on nutrition quality of pineapple cv. 'MD-2'.

Treatment	Carotenoid content (%)	Total soluble solids content (%)	Vitamin C content (%)	Titratable acidity content (%)	Soluble sugar content (mg/g)
EPE bag	2.63 ± 0.51 bc	10.47 ± 0.87 b	0.31 ± 0.05 ab	0.47 ± 0.03 b	58.89±14.59 b
White no-woven fabric bag	3.43 ± 0.07 b	9.97 ± 1.29 b	0.27 ± 0.01 b	0.52 ± 0.09 ab	81.37±16.28 ab
Black plastic bag	2.71 ± 1.01 bc	7.53 ± 1.62 c	0.35 ± 0.05 a	0.50 ± 0.07 ab	68.69±14.52 b
Kraft paper bag	1.84 ± 0.11 c	9.37 ± 0.32 bc	0.35 ± 0.00 a	0.56 ± 0.01 a	71.92±10.26 b
Control	8.20 ± 0.47 a	13.73 ± 1.50 a	0.18 ± 0.01 c	0.58 ± 0.08 a	101.78±13.52 a

Note: Different lower-case letters indicate significant differences between treatments at $P < 0.05$. Values are means ± SE.

Table 3 - Effects of different fruit bags on texture properties of pineapple cv. 'MD-2'.

Treatment	Hardness (N)	Cohesiveness (Ratio)	Springiness (mm)	Chewiness (mJ)
EPE bag	31.37 ±7.47 a	0.16 ±0.02 a	15.98 ± 0.86 ab	98.28 ±8.04 a
White no-woven fabric bag	14.13 ±4.76 b	0.15 ±0.01 a	15.56 ± 0.58 b	33.92 ± 10.44 b
Black plastic bag	23.23 ±8.53 ab	0.15 ±0.01 a	15.94 ± 0.79 ab	61.24 ± 7.18 ab
Kraft paper bag	28.50 ±1.01 ab	0.14 ±0.01 a	16.51 ± 1.09 ab	71.33 ± 6.77 ab
Control	21.13 ±3.96 ab	0.14 ±0.03 a	17.64 ±1.56 a	81.32 ± 5.39 ab

Note: Different lower-case letters indicate significant differences between treatments at $P < 0.05$. Values are means ± SE.

with paper bags showed no sunburn. There was no significant difference in fruit sunburn rate among four fruit bags. These four bags had the lowest fruit sunburn rate (0%).Fruit bagging could be effective in sunburn prevention.

Fruit weight is the common fruit quality of pineapple. In our study, fruit bagging significantly decreased fruit weight without crown. It is similar to the results of LU et al. (2010, 2011) reporting the effects of fruit bagging on fruit quality of pineapple cv. 'Smooth Cayenne' decreased fruit weight. The decrease of fruit weight might be caused by the decrease of light intensity on the fruit surface and the synthesis of photosynthetic products after bagging (LU et al., 2011). So reasonable debagging time should be studied in order to protect the fruit from sunburn and ensure photosynthesis.

The low number of fruit eyes is one of the important fruit qualities of pineapple. In our study, fruit bagging decreased the number of fruit eyes. The fruit eye is developed by small flower of pineapple. Fruit bagging could resist the light. It may be supposed that weak light affects the growth and development of flowers, so the number of fruit eyes was decreased. Fruit bagging could be favorable to improve the appearance of pineapple fruit.

Fruit bagging significantly decreased carotenoid content. It is accordant with the results of LU et al. (2011). This decrease may be caused by dark conditions due to bagging (ZHU et al., 2020). Timely debagging could alleviate the unfavorable effects of poor light due to bagging.

PRABHA et al. (2018) believed that fruit bagging could improve the total soluble solids content of pineapple cv. 'Mauritius'. Our studies showed different results from that of PRABHA et al. (2018). Fruit bagging could change the temperature around the fruit (BUTHELEZI et al., 2021). The temperature inside a fruit bag could be increased from 1 to 6 ℃ (OMAR et al., 2014). Higher temperature reduced soluble solids content of fruit. Fruit bag with 20 micron - perforation used in the study of PRABHA et al. (2018) could explain the reason for the increase of total soluble solids of fruit in a bag.

Fruit bagging decreased titratable acidity content. Our studies showed similar results to that of LU et al. (2010) and PRABHA et al. (2018). Fruit bagging could affect photosynthesis and respiration and reduce the accumulation of fruit inclusion, so titratable acidity content was decreased (WANG et al., 2017).

Fruit bagging decreased soluble sugar content. Our results were not coincident with the results of ZHAO et al. (2019). Fruit bagging time was speculated as the main reason. Fruit bagging was conducted on the 60th day after flower fading in the study of ZHAO et al. (2019) and relatively full sunlight could be helpful in the accumulation of soluble sugar (LADO et al., 2015; LIU et al., 2013). In this study, fruit bagging was conducted on the 40th day after flower fading.

Texture properties directly reflect flesh texture and the sensory taste of consumers, so they are important fruit qualities (NISHINARI et al., 2013). However, texture properties of pineapple fruit were often neglected except fruit hardness (LU et al., 2010; LU et al., 2011; ZHAO et al., 2019; PRABHA et al., 2018). Fruit with high hardness contributes to storage and transportation duration. LU et al. (2011) believed that fruit bagging had no significant influence on fruit hardness of pineapple. We reported significant differences of fruit hardness among four fruit bags. The inconsistence might be caused by measure tools. Hardness tester in the study of LU et al. (2011) was highly influenced by operators while texture analyzer in our study produced more objective results.

Application of EPE bag could bring about largest hardness and cohesiveness value and the second largest springiness value with no significant difference from the largest one. So, fruit bagging with EPE bag is beneficial to storage and transportation

of pineapple fruit. Chewiness can imitate taste of fruit when one sample fruit (SZCZESNIAK, 2002; WANG et al., 2014). Our results showed that pineapple fruit showed best chewiness when EPE bag was applied. In this study, texture properties analysis could provide references for further studying texture quality of pineapple fruit.

In conclusion, fruit bagging could prevention sunburn and influence fruit growth, external qualities, nutrition quality and texture properties of pineapple. Application of EPE bag could obtain better performance of fruit qualities of pineapple than that of white no-woven fabric bag, black plastic bag and kraft paper bag. Moreover, EPE bag is recyclable and reduce agricultural waste in pineapple production, so EPE bag had huge potential in environment-friendly production of pineapple. Debagging time should be further discussed.

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DECLARATION OF CONFLICT OF INTEREST

No potential conflict of interest was reported by the authors.

AUTHORS' CONTRIBUTIONS

YFZ and WXY performed the experiments. YFZ and WFZ analyzed the data. XHY drafted the manuscript. WFZ and XHY conceived and designed the experiments. WFZ and YFZ reviewed the manuscript. YFZ and WFZ acquisite funding. All authors read and approved the final manuscript.

REFERENCES

BARTHOLOMEW, D. P. 'MD-2' Pineapple Transforms the World's Pineapple Fresh Fruit Export Industry. **Pineapple News**, v.16, p.2-5, 2009. Available from: <http://ishs-horticulture.org/workinggroups/pineapple/PineNews16.pdf>. Accessed: Sep. 9, 2021.

BELL, D. et al. SURROUND® Crop protectant - for the reduction of sunburn damage and heat stress in pineapple. **Acta Horticulturae**, v.702, p.23, 2006. Available from: <https://doi.org/10.17660/ActaHortic.2006.702.23>. Accessed: Sep. 9, 2021.

BUTHELEZI, N. M. D. et al. Preharvest bagging as an alternative technique for enhancing fruit quality: A Review. **Horttechnology**, v.31, n.1, p.4-13, 2020. Available from: <https://doi.org/10.21273/HORTTECH04658-20>. Accessed: Sep. 9, 2021.

KISHORE, K. et al. Influence of shade intensity on growth, biomass allocation, yield and quality of pineapple in mango-based intercropping system. **Scientia Horticulturae**, v.278, p.109868, 2021. Available from: <https://doi.org/10.1016/j.scienta.2020.109868>. Accessed: Sep. 9, 2021.

LU, X. H. et al. Effects of bagging on fruit growth and quality of pineapple in different periods. **Chinese Journal of Tropical Crops**, v.31, p.1716-1719, 2010. Available from: <https://doi.org/10.3969/j.issn.1000-2561.2010.10.012>. Accessed: Sep. 9, 2021.

LU, X. H. et al. Effects of bagging with different paper bags on fruit growth and quality of pineapple. **Journal of Fruit Science**, v.28, p.1086-1089, 2011. Available from: <https://doi.org/10.13925/j.cnki.gsxb.2011.06.035>. Accessed: Sep. 9, 2021.

MUNNÉ-BOSCH, S., VINCENT, C. Physiological mechanisms underlying fruit sunburn. **Critical Reviews of Plant Sciences**, v.38, n.2, p.140-157, 2019. Available from: <https://doi.org/10.1080/07352689.2019.1613320>. Accessed: Sep. 9, 2021.

NISHINARI, K. et al. Parameters of texture profile analysis. **Food Science and Technology Research**, v.19, p.519-521, 2013. Available from: <https://doi.org/10.3136/fstr.19.519>. Accessed: Sep. 9, 2021.

OMAR, A. E. D. K. et al. Bagging of bunches with different materials influences yield and quality of Rothana date palm fruit. **Journal of Food and Agricultural Environment**, n.12, p.520-522, 2014. Accessed: Sep. 9, 2021.

PRABHA, S. et al. Effect of fruit bagging on physico-chemical properties of pineapple cv. Mauritius. **International Journal of Current Microbiology and Applied Sciences**, Special n.7, p.4876-4885, 2018. Accessed: Sep. 9, 2021.

RABIE, E. C., MBATHA, B. W. Evaluation of the efficacy of Eclipse® in reducing sunburn in 'Queen' pineapple of South Africa. **Acta Horticulturae**, v.1111, p.241-248, 2016. Available from: <https://doi.org/10.17660/ActaHortic.2016.1111.35>. Accessed: Sep. 9, 2021.

SHARMA, R. R. et al. Pre-harvest fruit bagging: a useful approach for plant protection and improved post-harvest fruit quality- a review. **Journal of Horticultural Science and Biotechnology**, v.89, p.101-113, 2014. Available from: <https://doi.org/10.1080/14620316.2014.11513055>. Accessed: Sep. 9, 2021.

SZCZESNIAK, A. S. Texture is a sensory property. **Food Quality and Preference**, v.13, p.215-225, 2002. Available from: <https://doi.org/10.1016/S0950-3293(01)00039-8>. Accessed: Sep. 9, 2021.

WANG, Q. Application prospects and perform and testing of non-woven bags. **China Fiber Inspection**, n.12, p.86-87, 2012. Available from: <https://doi.org/10.3969/j.issn.1671-4466.2012.12.038>. Accessed: Sep. 9, 2021.

WANG, Y. L. et al. Differential gene expression analysis of 'Chili' (*Pyrus bretschneideri*) fruit pericarp with two types of bagging treatments. **Horticultural Research**, n.4, p.17005, 2017. Available from: <https://doi.org/10.1038/hortres.2017.5>. Accessed: Sep. 9, 2021.

WANG, Y. X. et al. Flesh Texture characteristic analysis of pear. **Scientia Agriculturae Sinica**, v.47, p.4056-4066, 2014. Available

from: <https://doi.org/10.3864/j.issn.0578-1752.2014.20.014>. Accessed: Sep. 9, 2021.

KUMAR, V. et al. Integrated agricultural waste management: a solution of many problems. **Food and Scientific Reports**, n.1, p.63-64, 2020. Accessed: Sep. 9, 2021.

YAN, K. et al. Status quo of Agricultural Waste Resource Utilization in China and Its Prospects. **Agricultural Outlook**, n.7, p.62-65, 2019. Available from: <https://doi.org/10.3969/j.issn.1673-3908.2019.07.014>. Accessed: Sep. 9, 2021.

YUAN, Y. B. et al. Application of PP non-woven fruit bag in high quality and safety production of fruit trees. **China Fruit News**, n.6, p.32-34, 2013. Available from: <https://doi.org/10.3969/j.issn.1673-1514.2013.06.008>. Accessed: Sep. 9, 2021.

ZHANG, N. et al. The pineapple diseases and pests in China and their control. **South China Fruits**, n.3, p.52-55, 2009. Available from: <https://doi.org/10.13938/j.issn.1007-1431.2009.03.029>. Accessed: Sep. 9, 2021.

ZHAO, W. F. et al. Effects of color and covering time of sunshade net on yield and quality of *Ananas comosus*. **Guizhou Agricultural Science**, v.48, n.4, p.123-126, 2020a. Available from: <https://doi.org/10.3969/j.issn.1001-3601.2020.04.025>. Accessed: Sep. 9, 2021.

ZHAO, W. F. et al. Effects of different color shading nets and different shading heights on the yield and quality of golden pineapple. **Chinese Journal of Tropical Agriculture**, v.40, n.5, p.1-6, 2020b. Available from: <https://doi.org/10.12008/j.issn.1009-2196.2020.05.001>. Accessed: Sep. 9, 2021.

ZHAO, W. F. et al. Effects of time and height of shading on yield and quality of pineapple. **IOP Conference Series: Earth and Environmental Science**, v.512, p.012101, 2020c. Available from: <https://doi.org/10.1088/1755-1315/512/1/012101>. Accessed: Sep. 9, 2021.

ZHAO, W. F. et al. Effects of different bagging time and bag materials on yield and quality of pineapple. **Guangdong Agricultural Science**, v.46, p.27-33, 2019. Available from: <https://doi.org/10.16768/j.issn.1004-874X.2019.04.005>. Accessed: Sep. 9, 2021.

ZHU, M. et al. 2020. Effects of shading by bagging on carotenoid accumulation in peach fruit flesh. **Journal of Plant Growth and Regulation**. Available from: <https://doi.org/10.1007/s00344-020-10227-9>. Accessed: Sep. 9, 2021.

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