Effects of temperature on postharvest respiratory parameters and quality attributes of ackee (*Blighia sapida* Köenig) fruit arils during storage

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**Abstract**

The effect of temperatures on the rate of O$_2$ uptake (RR$_{O2}$) and CO$_2$ production (RR$_{CO2}$), the $Q_{10}$ and activation energy (Ea) of respiration, the respiratory quotient (RQ), the rate of ethylene production, the colour and visual quality attributes of ackee (*Blighia sapida* Köenig) fruit arils “cheese” variety were measured. RR$_{O2}$ averaged 0.26, 0.63, and 0.96 mmol kg$^{-1}$ h$^{-1}$ and RR$_{CO2}$ averaged 0.22, 0.55, 0.90 mmol kg$^{-1}$ h$^{-1}$ and ethylene production averaged, 47.5, 50.2 and 51.9 nmol kg$^{-1}$ h$^{-1}$ at 5, 15 and 25°C, respectively. Neither RR$_{O2}$ nor RR$_{CO2}$ correlated with ethylene production. The RQ of arils varied from 0.89 to 1.0 and the $Q_{10}$ varied from 1.8 to 2.0, while the Ea ranged from 40.4 to 51.6 kJ mole$^{-1}$. Decay and quality loss were rapid at temperatures above 15°C. When kept under chilling temperature (3°C for 20 days with or without subsequent removal to 25°C), ackee arils showed severe chilling injury symptoms. Decay was also accelerated by the removal to 25°C. Collectively, the data indicate that ackee fruit aril storage is limited to temperatures between 5°C and 15°C.

**Keywords**

Respiration, Ethylene, $Q_{10}$ chilling injury, Blighia sapida

**Introduction**

The ackee (*Blighia sapida* Köenig) belongs to the Sapindaceae and is a native plant of West Africa that was introduced to Jamaica in the 18th century. The fruit is a three-celled fleshy capsule containing three valves and three glossy black seeds. When ripe, the fruit splits longitudinally into three sections to reveal the seeds and the thick yellow flesh of the arils, which form the edible portion of the fruit and has a nutty flavor (Barnett, 1939; Barceloux, 2008).

Ripe ackee arils are widely consumed in the Caribbean and West Africa, one of the national dishes and considered as one of the national symbols in Jamaica. In Jamaica, two types of ackee are recognized – “cheese” or hard and “butter” or soft. The “cheese” ackee aril is hard, cream colored, and retains its shape when cooked and is the preferred one, while the “butter” ackee aril is soft and yellow, losing its shape easily during cooking.

Respiratory parameters of many fruits and their response to temperature have been the subject of numerous postharvest studies. The data are useful to producers and consumers, and can be employed in studies designed to evaluate or model shelf-life. Recently, Benkeblia (2014) investigated the effects of temperature on the respiration rate, ethylene production, and quality attributes of ackee fruit arils. Benkeblia (2014) found that the respiration rate (RR$_{CO2}$) for fruit stored at 5, 10 and 15°C declined with storage duration and with decreasing temperature. He also found that ethylene production, while decreasing as temperature declined, increased during storage, suggesting no linkage to respiratory activity per se. Apart from this work, no data are available on the respiratory parameters including respiratory quotient (RQ) of ackee fruit arils.

The responses of plant tissues to temperatures ranging from 0 to 5°C vary according to the tolerance of the species and are further affected by intrinsic and extrinsic factors (Graham and Patterson, 1982). Although refrigeration is the oldest known and classic technology used for extending the shelf-life and preserve the quality attributes of fresh crops, low temperatures are also known to have negative impacts on tropical crops (Wade, 1979; Paull, 1990,1999). Therefore, a proper storage temperature is needed to extend storage life of fresh crops and maintain the quality attributes of harvested crops. These appropriate temperatures should reduce the respiration rate and slow down the metabolic process, without affecting cellular integrity and causing...
metabolic stresses that lead to chilling injury (Parkin et al., 1989). On the other hand, postharvest quality attributes also depend on quality at harvest, and these would influence the shelf-life of perishables during storage (Benkeblia et al., 2011).

Damage in response to exposure to low temperatures, referred as chilling injury (CI), is an important issue for the postharvest sector because low temperature is one of the most classic techniques to extend the shelf-life of fresh crops (Lyons, 1973; Wang, 1989; Wang, 1994). In fruits and vegetables, CI symptoms appear in different ways depending on the species and the type of tissue (Jackman et al., 1988). Indeed, the rate of symptoms development is temperature dependent. The most common observed symptoms in tropical and subtropical fruit are surface pitting and necrosis, internal browning, skin and flesh discoloration and sensitivity to decay. CI symptoms may develop slowly during the chilling period, but their expression is greatly accelerated once the crops or tissues are transferred to warmer temperatures (i.e., above 20°C) (Jackman et al., 1988; Hatton 1990). Different methods are also used to alleviate the severity or symptoms development of CI such as controlling storage conditions (Hatton, 1990; Lurie and Sabehat, 1997), modified atmosphere packaging (Wang and Qi, 1997; Pesis et al., 2000), exogenous chemical treatments (Wang et al., 2006) as well as genetic manipulation to develop chilling-resistant crops (Fung et al., 2004; Sevillano et al., 2009).

The objective of this study is to calculate respiratory parameters needed for mathematically describing the respiratory rates for ackee fruit arils as a function of temperature, and to determine the susceptibility of arils to developing chilling injury at low temperatures and the impact of this disorder on some quality attributes of stored arils.

**Materials and Methods**

**Plant materials**

The ackee trees, ‘cheese’ variety, used for this study were grown in the Botanical Garden of the University of the West Indies. The fruits were randomly harvested from three different trees when the capsule was fully open and the samples were pooled. Immediately after harvest, the arils were carefully separated from the husk, placental tissues, and seeds. Removal of the arils can be accomplished without damage when the fruit are ripe, as the red placental membrane is very soft. After their separation and prior to physiological (RR and ethylene) assessments, arils were packed in polystyrene boxes for 24 h under each three temperature regimes (5 ± 1°C, 15 ± 1°C and 25 ± 1°C) to permit temperature equilibration. Alternately, fruit were held at 3°C to induce CI and subsequently held at 25°C to permit the expression of symptoms, as described in the section below.

**Respiration rates (RRO2 and RRCO2) assessment**

The respiration rates (RRO2 and RRCO2) were determined using a static respirometer method as described by Benkeblia et al. (2000). Detached arils (200 ± 10 g) were placed in 1-L glass jars previously equilibrated at the required temperature and stored in temperature-controlled rooms (5 and 15°C) and controlled room temperature (25°C). For each temperature, jars were closed and the gas composition of each jar analysed at seven time points 0, 1, 2, 3, 4, 5, and 6 h to be able to select only those data associated with aerobic respiration as of oxygen is depleted in the jar and CO2 increases. To also avoid changes in pressure in the jars that can occur following the removal of multiple gas samples, the air sample for composition analysis was circulated through the analyser (model ICA250, International Controlled Atmosphere Ltd Instrument Division, Kent, UK) and back to the chamber. The sampling duration was 2 min. Respiration rates (RRO2 and RRCO2) were calculated by fitting O2 depletion and CO2 accumulation data for the seven time points with a linear regression and expressed as mmol kg⁻¹ h⁻¹ O2 and depletion did not exceed 4% during the holding period. For each respiration measurement, three jars were used and measurements were duplicated.

**Ethylene production assessment**

Ethylene production was determined by the same method described for the respiration rate but using a different gas analyser (model ICA56, International Controlled Atmosphere Ltd Instrument Division, Kent, UK). Ethylene production was calculated by fitting ethylene accumulation data for the seven time points with a linear regression and expressed as nmol kg⁻¹ h⁻¹. For each ethylene measurement, three jars also were used and measurements were duplicated.

**RQ, Ea and Q10 calculation**

The respiratory quotient (RQ = RRCO2/RRO2) was determined for fruit at all three temperatures. The Q10 was determined by plotting log(RR) against temperature (T): Log(RR) = aT + b. The predicted respiration rate at 0°C (RR0) was calculated from the b coefficient (RR0 = 10b) and Q10 from the a coefficient (Q10 = 10a). Apparent activation energy (Ea) was calculated by Labuza (1980) based on Arrhenius equation, where T = temperature (K), Ea = activation energy (J mol⁻¹) and R = gas constant (8.3 J mol⁻¹ K⁻¹).
Chilling injury (CI) assessment

Susceptibility of ackee fruit arils to chilling injury was determined on six different lots of stored arils. For each lot, arils were removed and packed into polystyrene boxes, each containing approximately 250 g. The weight of individual arils ranged from 6.9 to 10.5 g and the average weight per aril was 8.1 ± 0.55 g. The arils were stored for 20 d at 3 ± 0.5°C and 85-90% relative humidity. For three of the lots, symptoms of CI were recorded after 5, 10, 15 and 20 d storage. For the remaining three lots, arils were held at 25°C for 1 to 2 additional days and incidence and severity of CI was recorded. The severity of chilling injury was also expressed as a chilling index (CINX) (Falik et al., 2009). The index (CINX) was calculated as follow:

\[
CINX = \frac{(AWND \times 0) + (AWMD \times 1) + (AWMdD \times 2) + (AWSD \times 3)}{\text{Total Number of arils}}
\]

where \( AWND \) = number of arils with no damage, \( AWMD \) = number of arils with minor damage (less than 10% damaged), \( AWMdD \) = number of arils with moderate damage (10 to 30% damaged), and \( AWSD \) = number of arils with severe damage (more than 30% damaged).

Colour assessment of arils during storage

The colour of the arils was measured on the surface of all fruits in each sample lot described previously using a chromameter (Model 400 chromameter, Konica Minolta Sensing Inc., Osaka, Japan) and the data were expressed in \( L^*, a^*, b^* \) values (CIE). The color reading was taken three times for each fruit (once for each section of the husk) at the equatorial region of each fruit and averaged to give a value for each fruit. The values \( a^* \) and \( b^* \) were used to calculate chroma \((C^* = \sqrt{a^*2 + b^*2})\), which indicates the intensity or colour saturation, and hue angle \((H^o = \text{arctangent}[b^*/a^*])\), where \(0^o = \text{red-purple}, 90^o = \text{yellow}, 180^o = \text{bluish-green}, \) and \(270^o = \text{blue} \) (McGuire, 1992).

Quality evaluation of ackee arils

Quality evaluation procedures were performed at room temperature (c.a. 25°C) as described previously (Wright and Kader, 1997; Agar et al., 1999). A panel of eight judges (5 men and 3 women) familiar with the appearance of ackee arils scored the visual quality of the stored arils. Quality evaluation of ackee arils was based on a 5-point hedonic scale as described below. Browning, shrivelling, wilting, and dryness were evaluated on a 5-point hedonic scale as follows: 5: no shrivelling evident (0%); 4: minor shrivelling (less than 20%); 3: moderate shrivelling (21% to 40%); 2: high shrivelling (> 40% to 60%); 1: very high shrivelling (> 60%). Gloss, odour, and overall rating were also evaluated on a 5-point hedonic scale as follows: 5: excellent (fresh cut); 4: very good; 3: acceptable; 2: poor; and 1: unusable.

Data analysis

Data were expressed as the means ± SD and analysed statistically by analysis of variance (ANOVA) using SPSS Version 19 statistical software (IBM Corp., Armonk (NY), USA), and statistical significance was determined at the level \( P \leq 0.05 \).

Results and Discussion

Respiration rates (RRCO2 and RRO2) and ethylene production

The respiration rate of ackee arils increased quasi-linearly with temperature from 5 to 25°C (Figures 1A and 1B). For the three measurements made at each temperature, the lowest \( RRCO2 \) were 0.19, 0.51 and 0.81 mmol kg\(^{-1}\) h\(^{-1}\) and the highest were 0.24, 0.58 and 0.99 mmol kg\(^{-1}\) h\(^{-1}\) at 5, 15 and 25°C, respectively. \( RRO2 \) were similar to those for \( RRCO2 \); the lowest of the three measurements made at each temperatures for \( RRO2 \) were 0.23, 0.58 and 0.89 mmol kg\(^{-1}\) h\(^{-1}\) and the highest were 0.29, 0.67 and 1.03 mmol kg\(^{-1}\) h\(^{-1}\) at 5, 15 and 25°C, respectively. Benkeblia (2014) reported data consistent with those described here, reporting freshly harvested ackee having a \( RRCO2 \) of 0.21, 0.41 and 0.78 mmol kg\(^{-1}\) h\(^{-1}\) at 5, 10 and 20°C, respectively. In the present study, the respiratory rates for oxygen uptake and \( CO_2 \) production both increased approximately four-fold between 5 and 25°C. While the temperature sensitivity of respiration differs between commodities, the data for ackee are rather typical in that the respiratory rate for most fruits and vegetables increases by 2- to 6- fold from 0 to 15°C (Beaudry et al., 1992; Cameron et al., 1994; Lakakul et al., 1999).

Ethylene production by the ackee arils increased with temperature, but the effect of temperature was very weak (Figure 1C). Aril ethylene production averaged 47.9, 50.2 and 51.9 nmol kg\(^{-1}\) h\(^{-1}\) at 5, 15 and 25°C, respectively. The rate of ethylene production reported by Benkeblia (2014) was also consistent with ours, averaging 47.6 nmol kg\(^{-1}\) h\(^{-1}\) at 20°C, although temperature sensitivity was higher in the previous study.
RQ, $Q_{10}$ and $E_a$

Although there is extensive literature on many physiological parameters of fresh crops, there is only one report on a limited number of these parameters in ackee (Benkeblia, 2014). Our data provide the first estimate of the RQ of ackee arils. The RQ of ackee fruit arils increased with temperature, averaging 0.83, 0.98, and 0.98 at 5, 15 and 25°C, respectively (Table 1). These data are consistent with the findings of previous reported works on other perishable crop species (Platenius, 1942; Hagger et al., 1992; Benkeblia et al., 2000). Beside temperature and atmosphere composition, other factors influence the RQ such as the commodity composition (Platenius, 1942) and microbial charge (Benkeblia et al., 2000). Although the ackee arils RQ was similar to that of many crops, we noticed that the values averaged slightly below. This may reflect oxidation of lipids, which are contained in high levels in arils (Odutuga et al., 1992). That lowest RQ values were observed at 5°C, suggesting that metabolism is shifted toward lipid degradation at low temperatures. This is consistent with the findings of Eaks and Morris (1956) for cucumber, which has a chilling threshold near 10°C.

The $Q_{10}$ of ackee fruit arils for O$_2$ and CO$_2$ respiration rates were 1.81 and 2.01, respectively (Table 1). The corresponding $E_a$ of respiration for ackee fruit arils ranged from 40.4 to 51.6 kJ mole$^{-1}$ and averaged, 41.5 and 47.6 kJ mole$^{-1}$ for O$_2$ and CO$_2$, respectively (Table 1). The calculated respiratory rates for O$_2$ and CO$_2$ at 0°C (i.e., $RR_{0(O2)}$ and $RR_{0(CO2)}$) averaged 0.213 and 0.167 mmol kg$^{-1}$ h$^{-1}$, respectively (Table 1).

Reported $Q_{10}$ values for other crops range from 2.5 to 4.0 between 0 and 10°C, and from 1.5 to 2.0 between 20 and 30°C (Kader, 1987; Cameron et al., 1994; Makino et al., 1996; Varoquaux et al.,

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**Table 1. Respiratory parameters of ackee fruit arils determined under three temperature regimes**

<table>
<thead>
<tr>
<th>Temperature</th>
<th>Lowest</th>
<th>Highest</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>0.83</td>
<td>0.84</td>
<td>0.83</td>
</tr>
<tr>
<td>15</td>
<td>0.97</td>
<td>1</td>
<td>0.98</td>
</tr>
<tr>
<td>25</td>
<td>0.96</td>
<td>0.99</td>
<td>0.98</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>RR$_{0(O2)}$ (mmol kg$^{-1}$ h$^{-1}$)</th>
<th>0</th>
<th>0.175</th>
<th>0.226</th>
<th>0.213 $R^2=0.98$</th>
</tr>
</thead>
<tbody>
<tr>
<td>RR$_{0(CO2)}$ (mmol kg$^{-1}$ h$^{-1}$)</td>
<td>0</td>
<td>0.145</td>
<td>0.183</td>
<td>0.167 $R^2=0.95$</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>$Q_{10}$</th>
<th>O$_2$</th>
<th>1.799</th>
<th>1.91</th>
<th>1.806</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>CO$_2$</td>
<td>1.97</td>
<td>2.07</td>
<td>2.01</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Activation energy ($E_a$)</th>
<th>O$_2$</th>
<th>40,422</th>
<th>43,567</th>
<th>41,504</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>CO$_2$</td>
<td>46,525</td>
<td>51,594</td>
<td>47,605</td>
</tr>
</tbody>
</table>
1999; Fonseca et al., 2002; Nei et al., 2005). Like Ea, the value of \( Q_{10} \) is also related to the sensitivity of deterioration to temperature, with a higher value portending a more rapid rate of quality decline as temperature increases (Lee et al., 1991; Kays 1997; Hertog et al., 1998; Kader, 2011).

Despite this interpretation of the utility of \( Q_{10} \), the rate of fresh crop deterioration is not typically first-order against the reciprocal of temperatures (Kruse et al., 2011). It well established that the respiration rate does not typically follow a linear trend with temperature due to the complexity of this process, which can be influenced by several intrinsic factors such as maturity stage, variety, internal moisture and type of tissue (Day, 1993; Kruse et al., 2011). Although the instantaneous response of plant respiration to temperature change can be approximated by Arrhenius kinetics, to more fully account for a dynamic response, Kruse et al. (2011) suggested combining Arrhenius and Michaelis–Menten kinetics.

### Colour assessment of arils during cold storage

When ackee arils were kept at the chilling temperature of 3°C, tissues browned as indicated by the decrease in \( a^* \) and \( b^* \) values and an increase in hue angle (Table 2). When stored at 3°C and then removed to 25°C, ackee arils browned more than when held at 3°C only. The values of \( L^* \) decline with storage in a manner similar to that reported by Benkeblia (2014). Benkeblia (2014) noticed that higher storage temperatures did not affect the colour of the arils, and this might indicate that arils do not tolerate temperatures below 5°C, which appears to be detrimental to the quality attributes of this produce. Although not directly comparable, pomegranate arils have also been reported to darken when stored at 5°C (Kruse et al., 2011). Although the instantaneous response of plant respiration to temperature change can be approximated by Arrhenius kinetics, to more fully account for a dynamic response, Kruse et al. (2011) suggested combining Arrhenius and Michaelis–Menten kinetics.

#### Table 2. Colour of ackee fruit arils kept 3°C for up to twenty days with and without removal to 25°C for one (20 d) or two (0 - 15 d) days. Values of the same column with different superscripts are significantly different at \( P \leq 0.05 \).

<table>
<thead>
<tr>
<th>Storage period (days)</th>
<th>( L^* )</th>
<th>( a^* )</th>
<th>( b^* )</th>
<th>( a^<em>/b^</em> )</th>
<th>( C^* )</th>
<th>( H^o )</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>68.32( a )</td>
<td>9.93( a )</td>
<td>59.61( a )</td>
<td>0.16( a )</td>
<td>60.43( a )</td>
<td>-3.48( a )</td>
</tr>
<tr>
<td>5</td>
<td>66.45( a )</td>
<td>9.41( a )</td>
<td>51.76( a )</td>
<td>0.18( a )</td>
<td>52.61( a )</td>
<td>-1.01( a )</td>
</tr>
<tr>
<td>10</td>
<td>61.73( b )</td>
<td>8.74( b )</td>
<td>52.18( b )</td>
<td>0.16( b )</td>
<td>52.91( b )</td>
<td>-3.09( b )</td>
</tr>
<tr>
<td>15</td>
<td>56.76( c )</td>
<td>7.08( c )</td>
<td>43.68( c )</td>
<td>0.14( c )</td>
<td>51.17( c )</td>
<td>0.83( c )</td>
</tr>
<tr>
<td>20</td>
<td>54.36( c )</td>
<td>6.18( c )</td>
<td>35.61( c )</td>
<td>0.17( c )</td>
<td>36.14( c )</td>
<td>-1.74( c )</td>
</tr>
</tbody>
</table>

\( 3^oC + 1 \) to 2 d at 25°C

<table>
<thead>
<tr>
<th>Storage period (days)</th>
<th>( L^* )</th>
<th>( a^* )</th>
<th>( b^* )</th>
<th>( a^<em>/b^</em> )</th>
<th>( C^* )</th>
<th>( H^o )</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>68.32( a )</td>
<td>9.93( a )</td>
<td>59.61( a )</td>
<td>0.16( a )</td>
<td>60.43( a )</td>
<td>-3.48( a )</td>
</tr>
<tr>
<td>5</td>
<td>59.45( b )</td>
<td>8.03( b )</td>
<td>43.53( b )</td>
<td>0.18( b )</td>
<td>44.26( b )</td>
<td>-0.86( b )</td>
</tr>
<tr>
<td>10</td>
<td>48.36( c )</td>
<td>7.01( c )</td>
<td>29.25( c )</td>
<td>0.24( c )</td>
<td>30.08( c )</td>
<td>0.59( c )</td>
</tr>
</tbody>
</table>

* colour data could not be accurately determined due to the presence of moulds.
Figure 2. Representative images of arils of ackee fruits stored at 3 °C for up to twenty days (20) with or without transfer to 25 °C for 1 or two days. Arils in these images were not used for analyses.

Table 3. Sensory and quality indices of ackee fruit arils kept 3°C for twenty days with and without post-storage holding at 25°C

<table>
<thead>
<tr>
<th>Temperature</th>
<th>3°C</th>
<th>3°C + 1 to 2 d at 25°C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Storage (days)</td>
<td>5</td>
<td>10</td>
</tr>
<tr>
<td>CINX</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Browning</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>Shrivelling</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Wilting</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>Dryness</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>Gloss</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>Odour</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>Decay</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Visual quality</td>
<td>4.5</td>
<td>3</td>
</tr>
<tr>
<td>Overall Rating</td>
<td>5</td>
<td>3</td>
</tr>
</tbody>
</table>

Chilling index (CINX): [(no. fruit with no damage *0) + (no. with minor damage * 1) + (no. with moderate damage * 2) + (no. with severe damage * 3)]/total fruit


Gloss, odour, and overall rating: 5: excellent; 4: very good; 3: acceptable; 2: poor; 1: unusable

Effects of chilling temperature on stored ackee arils quality

Arl quality was acceptable after five days storage at 3°C. After an additional 2 d at 25°C (room temperature), the quality declined, but the arils were still acceptable commercially. After 10 days at 3°C, the arils were still considered marketable, while at 3°C + 2 days at 25°C, the quality was poor and the arils started to decay (Table 3 and Figure 2). After 15 days at 3°C, the arils were of poor quality but still no moulds observed, while at 3°C + 2 days the arils were severely infected by moulds and off-flavours were detected. After twenty days, under both conditions (3°C and 3°C + 2 days at 25°C) ackee arils were already decaying, although the decay at 3°C + 1 day was more invasive after one day only (Table 3 and Figure 2).

Conclusion

From the results, it is shown that the respiratory rate of ackee fruit arils is sensitive to temperature. The arils, unprotected by a skin and damaged slightly by the removal of the seed and placental tissues, have a very short shelf-life. Chilling injury was noted within 10 days when holding at 3°C, so higher storage temperatures are suggested. Post-storage removal to high temperature following chilling temperatures accelerated decay and tissue breakdown. Results showed that ackee arils do not tolerate very low or very high temperatures, and storage at intermediate temperatures may be optimal. Additional work describing the response of ackee arils to O₂ and CO₂ would be pertinent for the development of models
appropriate for modified atmosphere packaging to extend further the shelf-life of ackee fruit arils. To this end, the temperature responses for \( RR_{O2} \) and \( RR_{CO2} \) in terms of \( RQ \), \( Ea \) and \( Q_{10} \) provide needed data. Lacking is the determination of the apparent \( Km \) as a function of temperature to enable the creation of temperature-sensitive predictive models for package design (Cameron et al., 1994).

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References


