Agricultural Science 2019 v1.3

IA2 high-level annotated sample response 2

February 2024

Student experiment (20%)

This sample of student work has been published by the QCAA to assist and support teachers to match evidence in student responses to the characteristics described in the instrument-specific marking guide (ISMG).

The sample is an unedited authentic student response produced with permission. Any identifying features have been redacted from the response. It may contain errors and/or omissions that do not affect its overall match to the characteristics indicated.

Assessment objectives

2. apply understanding of animal production, plant production or agricultural enterprises to modify experimental methodologies and process primary data
3. analyse experimental evidence about animal production, plant production or agricultural enterprises
4. interpret experimental evidence about animal production, plant production or agricultural enterprises
5. investigate phenomena associated with animal production, plant production or agricultural enterprises through an experiment
6. evaluate experimental processes and conclusions about animal production, plant production or agricultural enterprises
7. communicate understandings and experimental findings, arguments and conclusions about animal production, plant production or agricultural enterprises.

Queensland Government
Queensland Curriculum & Assessment Authority
231054

Instrument-specific marking guide (ISMG)

Criterion: Research and planning

Assessment objectives

2. apply understanding of animal production, plant production or agricultural enterprises to modify experimental methodologies and process primary data
5. investigate phenomena associated with animal production, plant production or agricultural enterprises through an experiment

The student work has the following characteristics:	Marks
• informed application of understanding of animal production, plant production or agricultural enterprises to modify experimental methodologies demonstrated by – a considered rationale for the experiment – justified modifications to the methodology • effective and efficient investigation of phenomena associated with animal production, plant production or agricultural enterprises demonstrated by – a specific and relevant research question – a methodology that enables the collection of sufficient, relevant data – considered management of risks and ethical or environmental issues.	5–6
• adequate application of understanding of animal production, plant production or agricultural enterprises to modify experimental methodologies demonstrated by – a reasonable rationale for the experiment – feasible modifications to the methodology • effective investigation of phenomena associated with animal production, plant production or agricultural enterprises demonstrated by – a relevant research question – a methodology that enables the collection of relevant data – management of risks and ethical or environmental issues.	3–4
• rudimentary application of understanding of animal production, plant production or agricultural enterprises to modify experimental methodologies demonstrated by – a vague or irrelevant rationale for the experiment – inappropriate modifications to the methodology • ineffective investigation of phenomena associated with animal production, plant production or agricultural enterprises demonstrated by – an inappropriate research question – a methodology that causes the collection of insufficient and irrelevant data – inadequate management of risks and ethical or environmental issues.	1–2
• does not satisfy any of the descriptors above.	0

Criterion: Analysis of evidence

Assessment objectives

2. apply understanding of animal production, plant production or agricultural enterprises to modify experimental methodologies and process primary data
3. analyse experimental evidence about animal production, plant production or agricultural enterprises
5. investigate phenomena associated with animal production, plant production or agricultural enterprises through an experiment

The student work has the following characteristics:	Marks
• appropriate application of algorithms, visual and graphical representations of data about animal production, plant production or agricultural enterprises demonstrated by correct and relevant processing of data • systematic and effective analysis of experimental evidence about animal production, plant production or agricultural enterprises demonstrated by − thorough identification of relevant trends, patterns or relationships − thorough and appropriate identification of the uncertainty and limitations of evidence • effective and efficient investigation of phenomena associated with animal production, plant production or agricultural enterprises demonstrated by the collection of sufficient and relevant raw data.	5–6
• adequate application of algorithms, visual and graphical representations of data about animal production, plant production or agricultural enterprises demonstrated by basic processing of data • effective analysis of experimental evidence about animal production, plant production or agricultural enterprises demonstrated by − identification of obvious trends, patterns or relationships − basic identification of uncertainty and limitations of evidence • effective investigation of phenomena associated with animal production, plant production or agricultural enterprises demonstrated by the collection of relevant raw data.	3–4
• rudimentary application of algorithms, visual and graphical representations of data about animal production, plant production or agricultural enterprises demonstrated by incorrect or irrelevant processing of data • ineffective analysis of experimental evidence about animal production, plant production or agricultural enterprises demonstrated by − identification of incorrect or irrelevant trends, patterns or relationships − incorrect or insufficient identification of uncertainty and limitations of evidence • ineffective investigation of phenomena associated with animal production, plant production or agricultural enterprises demonstrated by the collection of insufficient and irrelevant raw data.	1–2
• does not satisfy any of the descriptors above.	0

Criterion: Interpretation and evaluation

Assessment objectives

4. interpret experimental evidence about animal production, plant production or agricultural enterprises
6. evaluate experimental processes and conclusions about animal production, plant production or agricultural enterprises

The student work has the following characteristics:	Marks
• insightful interpretation of experimental evidence about animal production, plant production or agricultural enterprises demonstrated by justified conclusion/s linked to the research question • critical evaluation of experimental processes about animal production, plant production or agricultural enterprises demonstrated by – justified discussion of the reliability and validity of the experimental process – suggested improvements and extensions to the experiment that are logically derived from the analysis of evidence.	5–6
• adequate interpretation of experimental evidence about animal production, plant production or agricultural enterprises demonstrated by reasonable conclusion/s relevant to the research question • basic evaluation of experimental processes about animal production, plant production or agricultural enterprises demonstrated by – reasonable description of the reliability and validity of the experimental process – suggested improvements and extensions to the experiment that are related to the analysis of evidence.	3–4
• invalid interpretation of experimental evidence about animal production, plant production or agricultural enterprises demonstrated by inappropriate or irrelevant conclusion/s • superficial evaluation of experimental processes about animal production, plant production or agricultural enterprises demonstrated by – cursory or simplistic statements about the reliability and validity of the experimental process – ineffective or irrelevant suggestions.	1–2
• does not satisfy any of the descriptors above.	0

Criterion: Communication

Assessment objectives

7. communicate understandings and experimental findings, arguments and conclusions about animal production, plant production or agricultural enterprises

The student work has the following characteristics:	Marks
• effective communication of understandings and experimental findings, arguments and conclusions about animal production, plant production or agricultural enterprises demonstrated by – fluent and concise use of scientific language and representations – appropriate use of genre conventions – acknowledgment of sources of information through appropriate use of referencing conventions.	2
• adequate communication of understandings and experimental findings, arguments and conclusions about animal production, plant production or agricultural enterprises demonstrated by – competent use of scientific language and representations – use of basic genre conventions – use of basic referencing conventions.	1
• does not satisfy any of the descriptors above.	0

Task

Modify (i.e. refine, extend or redirect) an experiment in order to address your own related hypothesis or question.

You may use a practical performed in class, a related simulation or another practical related to Unit 3 (as negotiated with your teacher) as the basis for your methodology and research question.

See IA2 sample assessment instrument: Student experiment (20%) (available on the QCAA Portal).

Sample response

Criterion	Marks allocated	Provisional marks
Research and planning Assessment objectives 2, 5	6	6
Analysis and interpretation Assessment objectives 2, 3, 5	6	6
Conclusion and evaluation Assessment objectives 4, 6	6	6
Communication Assessment objective 7	2	2
Total	**20**	**20**

The annotations show the match to the instrument-specific marking guide (ISMG) performance-level descriptors.

The effect of Temperature on Capsicum Annuum

Abstract

Australia produces around 77 000 tons of capsicums (Capsicum annum) every year valuing at $171 million in 2019 making it a valuable industry with a strong growth predicted into the future.

Rationale

Research and planning [5–6]

a considered rationale for the experiment

The rationale contains evidence of a logical, informed basis for the experiment.

Communication [2]

acknowledgment of sources of information through appropriate use of referencing conventions

The use of in-text referencing fits the purpose of a scientific report.

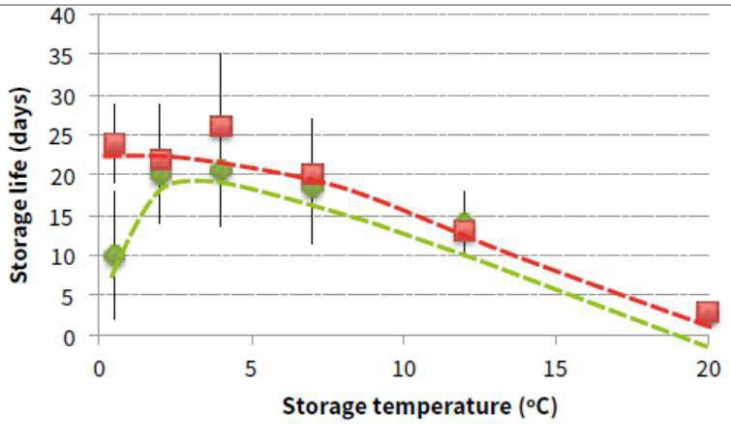
Research and planning [5–6]

a considered rationale for the experiment

The response carefully communicates the purpose and reasons for the experiment.

The agricultural industry is renowned for causing many global sustainability issues, and in Australia it's no different. Waste is a major issue in all aspects of production. According to Larissa, (2020), in Australia around 25% of fruit and vegetables are wasted before they leave the farm due to unsatisfactory post-harvest handling procedures and tight industry eligibility, costing the industry $3.8 billion per year. This is a major issue that can be easily addressed with research into specific plant products and what post-harvest handling practices are required to maintain high quality products that have a long shelf life, therefore reducing wastage. Post-harvest handling is a set of procedures that ensure each individual product meets industry standards by the time it is sold as a final product to consumers. Processes include the selection of fruit and vegetables against a certain market criterion, washing and packing of the product, transportation and storage. Throughout all these processes' conditions must be kept optimum and specific to what the product is which includes temperature, CO_2,O_2 and ethylene levels (Scott Trimble, 2019), to maintain a high quality and shelf life.

Australia produces around 77 000 tons of capsicums (Capsicum annum) every year valuing at $171 million in 2019 (Capsicum production and growth in Australia during 2019, 2020), making it a valuable industry with strong growth predicted into the future. Capsicums require a careful post-harvest management plan, with temperature one of the most important factors along with light, humidity and packaging. The optimal conditions for capsicums to maintain a >20 day shelf life, according to Ekman, Goldwater and Winley, is between 1-5°C with shelf life degrading quickly when temperature increases, as can be seen in figure 1. To investigate the influence of temperature on the shelf life and quality of capsicums is a worthwhile experiment due to the importance of reducing waste in the agricultural industry.



Storage life of red (■) and green (●) greenhouse grown capsicums at different temperatures. Bars indicate the likely variability around each mean value.

Figure 1: Optimal temperatures for red and green capsicums (Ekman, Jenny; Goldwater, Adam; Winley, Emma (2016)

Research and planning [5–6]

a specific and relevant research question

The research question is connected to the rationale and enables effective investigation of the topic.

Research Question:

What is the most suitable temperature between 3 and 29°C for Capsicum annum in terms of shelf life (mass) and post-harvest quality (i.e. visual appearance)?

Research and planning [5–6]

justified modifications to the methodology

The response gives sound reasons for how the modifications to the methodology will refine, extend or redirect the original experiment.

a methodology that enables the collection of sufficient, relevant data

The methodology shows careful and deliberate thought. It enables collection of adequate data so an informed conclusion to the research question can be drawn.

Modifications:

The purpose of this experiment is to refine and redirect an experiment that was conducted in class. It investigated how different post-harvest handling conditions, including various temperatures and packaging, affected apples, bananas and strawberries. The data from an experiment conducted by Ekman, Goldwater and Winley (shown in *figure 1*) showed the effect of temperature on red and green capsicums shelf life and was used to guide experiments modifications.

Modification to original experiment	Reasons for modifications
Refine and extend temperatures from room temperature and 4 degrees to 3°C, 6°C, 18°C and 29°C.	The original experiment investigated the effect of two different temperatures, so this was refined to see how a wider range of temperatures effected the post-harvest quality of capsicums.
Refine by having no plastic wrap on any capsicum.	The original had some trials with plastic wrap and some without, however to refine this experiment no plastic wrap is used. Capsicums don't get stored in individual plastic wraps, only in larger plastic bags in supermarkets when chosen.
Redirect by using red capsicums instead of bananas, strawberries and apples.	Instead of looking at a variety of produce, one was chosen that frequently goes rotten post-harvest.
Extend by investigating the colour and observations of capsicums.	By investigating how the capsicums appear visually, it will ensure that the quality is suitable for consumers.

Research and planning [5–6] **considered management of risks and ethical or environmental issues** The response shows careful and deliberate identification and planning to handle risks. The response does not mention ethical or environmental issues, but there are no such issues relevant to this research question.	

Risk Management:

Below risks are outlined, however the full risk assessment can be found in Appendix 3.

Risks identified	Management strategy
Food poisoning from capsicums	Do not eat any capsicum, as all have been in various temperatures and in an unsanitary environment in the science laboratory.
A high risk of mould and different bacteria's that could be dangerous on rotting capsicums.	Use gloves later in the experiment as capsicums go soft.
Technology and moisture	Capsicums may have condensation on outer, so avoid having laptop around capsicums, and use care around electronic scales.

Processed Data:

Analysis of evidence [5–6]

collection of sufficient and relevant raw data

The raw data is adequate for forming a conclusion and has direct bearing upon the research question. Four variations of the independent variable and three repetitions of each measurement are adequate.

Analysis of evidence [5–6]

correct and relevant processing of data

Raw data is manipulated accurately to provide evidence that is applicable to the research question.

Communication [2]

appropriate use of genre conventions

The response follows scientific conventions of the construction of tables.

The data that was collected (mass of capsicums) was not suitable enough as all the capsicums had variable initial masses. These values were converted into the cumulative percentage change of mass over the course of the experiment. The raw data that was used to find these values can be found in appendix 4. The calculations to find the following data can be found in Table 2.

	Initial masses (grams)	Cumulative % change (loss) of initial capsicum mass			
Temperature (°C) and trials	Day 0	Day 5	Day 8	Day 12	Day 14
29 a	196.66	14.42	22.23	32.87	38.45
29 b	221.95	15.20	23.03	31.92	36.05
29 c	281.06	12.60	19.59	28.93	34.13
MEAN		14.07	21.62	31.24	36.21
SD		1.33	1.80	2.05	2.16
SE		0.77	1.04	1.19	1.25
18 a	174.47	7.66	11.19	14.29	16.05
18 b	250.59	7.05	10.18	13.09	14.52
18 c	268.49	11.32	10.82	14.02	15.59
MEAN		8.68	10.73	13.80	15.39
SD		2.31	0.51	0.63	0.79
SE		1.33	0.30	0.36	0.45
6 a	273.14	2.12	3.30	5.00	5.69
6 b	190.03	2.86	4.46	6.89	7.79
6 c	183.65	3.83	5.83	8.25	9.53
MEAN		2.94	4.53	6.72	7.67
SD		0.85	1.27	1.63	1.92
SE		0.49	0.73	0.94	1.11
3 a	215.76	2.15	3.04	4.56	5.26
3 b	231.86	1.50	2.39	3.32	3.79
3 c	245.78	1.04	1.46	2.12	2.42
MEAN		1.56	2.29	3.33	3.82
SD		0.56	0.79	1.22	1.42
SE		0.32	0.46	0.70	0.82

Table 1: Cumulative percentage change of mass over 14days for red capsicums, in 4 different temperatures of 3, 6, 18 and 29°C, with averages, standard deviation and standard error.

Sample Calculation	Example of calculation
% change from original mass (loss)	For 29a, Day 5: $\% \, change = \frac{difference}{original} \times 100$ $\% \, change = \frac{196.66 - 168.3}{196.66} \times 100$ $= 14.42\%$
Average/Mean	For 29°C at 5 days: $m = \frac{sum \, of \, all \, values}{number \, of \, values}$ $m = \frac{(14.42 + 15.20 + 12.60)}{3}$ $m = 14.07\%$
Standard Deviation (SD) and Standard Error (SE)	Using excel, the following formulas were used to find the values for all. SD =STDEVA(x1:x2) SE =STDEVA(x1:x2)/SQRT(3)

Table 2: Sample for calculations for values in Table 1.

Analysis of evidence [5–6]

collection of sufficient and relevant raw data

The raw data is adequate for forming a conclusion and has direct bearing upon the research question. Four variations of the independent variable and three repetitions of each measurement are adequate.

°C	INTITAL	FINAL
29 a		
29 b		
29 c		
18 a		
18 b		
18 c		
6 a		
6 b		
6 c		
3 a		
3 b		
3 c		

Table 3: The colours of each capsicum initially and finally after 14 days, in 4 different temperatures, 3, 6 and 29°C, measured from a specific part of the capsicum, which can be seen in figure 2.

Analysis of evidence [5–6]

correct and relevant processing of data

Raw data is manipulated accurately to provide evidence that is applicable to the research question.

Observations	First day	8th day	Last day
29°C	Firm	Very wrinkled, skin coming off, beginning to decompose.	Very wrinkled, mould patches on c and a.
18°C	Firm	Soft, slightly wrinkled	Soft, slightly wrinkled
3°C	Firm	Firm	Firm
6°C	Firm	Firm	Starting to go soft and starting to wrinkle.

Table 4: Observations over 14 days of the capsicums, initially, half way and on the last trial day, of four temperatures (3, 6, 18 and 29°C).

Communication [2]

fluent and concise use of scientific language and representations

The response represents data clearly so that the trends, patterns and relationships can be easily identified.

Communication [2]

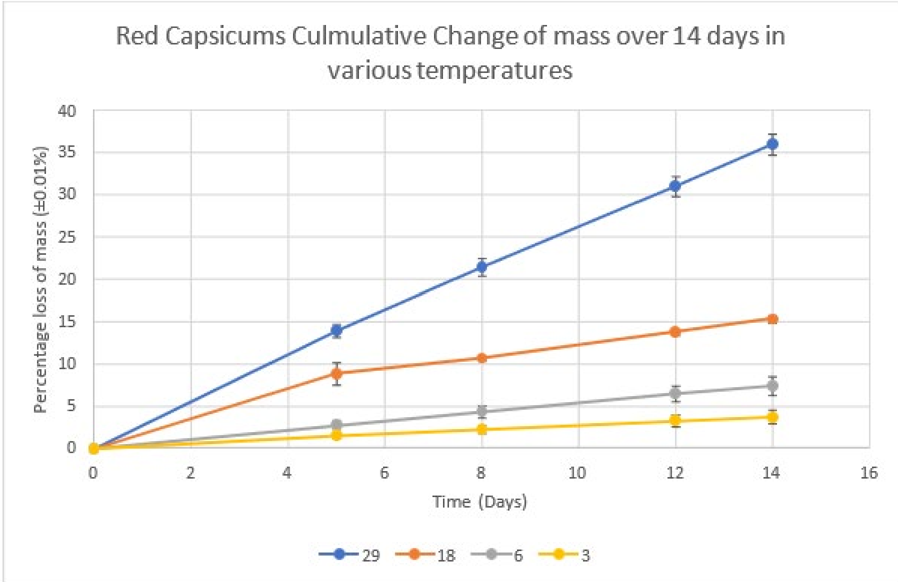
appropriate use of genre conventions

The response follows scientific conventions of the construction of graphs.

Analysis of evidence [5–6]

correct and relevant processing of data

Raw data is manipulated accurately to provide evidence that is applicable to the research question.

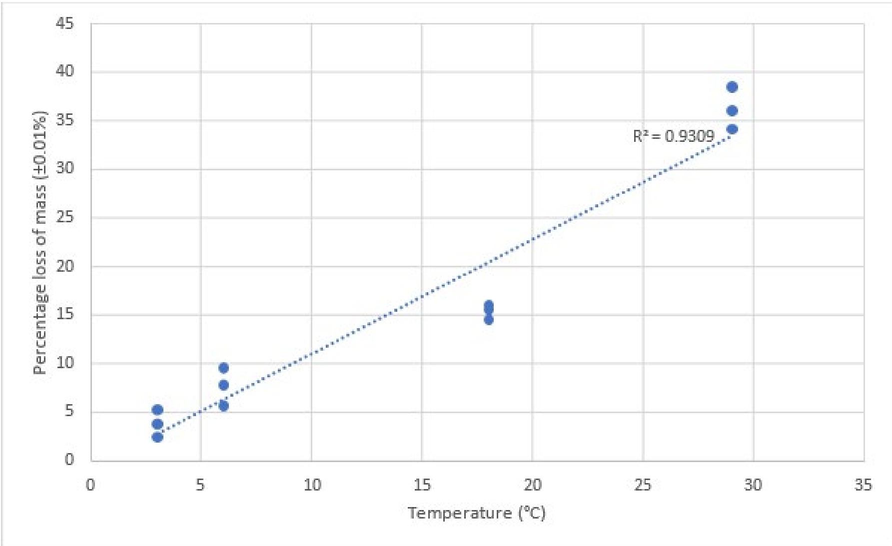


Graph 1: How temperature affects capsicums over 14 days in various indoor and fridge temperatures of 29, 18, 6 and 3°C.

Communication [2]

fluent and concise use of scientific language and representations

The response represents data in an appropriate format to ensure that the trends, patterns and relationships can be accurately interpreted.



Graph 2: Percentage loss of mass in capsicums after 14 days in various temperatures.

Discussion of results:

Analysis of evidence [5–6]

thorough identification of relevant trends, patterns or relationships

The response identifies trends, patterns or relationships that are applicable to the

Graph and Table 1 show that all capsicums lose mass in all conditions. 29°C has the largest loss of mass by 14 days, on average 36.21% of initial mass was lost. This appreciates over 14 days, displaying a relatively consistent loss. Following this 18°C has a similar pattern, however the trend flattens slightly after 5 days with the final average loss at 15.38%. 3°C and 6°C has a very similar trend however final mass loss was different. The lowest temperature lost on average 3.82% of initial mass, a very small change over 14 days, however capsicums in 6°C lost a mean of 7.67% of initial mass. The capsicums in 29°C lost the most, over double of what the capsicums in 18°C lost and is the same pattern for each condition. So, as the temperatures increase, from 3 to 6 to 18, the % loss of the capsicums roughly doubles each time. This suggests there is a

research question. **Analysis of evidence [5–6]** **thorough and appropriate identification of the uncertainty and limitations of evidence** The response examines the uncertainty to determine if the evidence that will be used to draw a conclusion to the research question is reliable and valid.	very strong relationship between temperature and capsicum mass loss over time, and clearly shows that 3°C is the best temperature for capsicums. This is evident in graph 2, where 93% (r^2=0.9309) of the data depends on the temperature after 14 days in various temperatures, showing there is a clear trend. Standard error, displayed in graph and table 1, is small for all variables and conditions. For capsicums in 29°C, standard error is low but increases over the 14-day period (0.77% to 1.25%) and is low relative to the mean of 36.21%. This trend is seen in the 3°C and 6°C conditions as well, which consistently stayed low over the 14-day period. 3°C capsicums have a standard error that is larger compared to the mean, therefore is more variable and slightly less valid. 18°C capsicums on day-5 have a large standard error, of 8.68%±1.33, an anomaly compared to the other temperatures at 5-days. This recedes to significantly smaller values for the remainder of the experimental period, ranging between 0.3% and 0.45%, all very low values. Overall, though the standard error does increase slightly for most variables over the 14 days, they are very small and show high validity.
Analysis of evidence [5–6] **thorough and appropriate identification of the uncertainty and limitations of evidence** The response examines the uncertainty to determine if the evidence that will be used to draw a conclusion to the research question is reliable and valid.	Standard deviation, shown in table 1, follows a similar growth pattern to standard error, however is larger. The 29°C capsicums at 14- days had a standard deviation of 2.16% (mean=36.21%). Though it increased over the 2-week period, these values are low compared to the mean, showing the data is precise. This trend is the same for 3°C and 6°C, however, the issue with these two conditions is that the standard deviations are comparatively larger to the mean. There was an unusually large standard error for capsicums at 18°C after 5-days, of 2.31% (mean=8.68%) which was an anomaly. After this irregularity, the standard deviations fell significantly to low values between 0.51% and 0.79%. It is evident that the data is precise, though overall preciseness decreases slightly as temperatures cool.  *Figure 2: photo of red capsicums in order from the top to the bottom of the temperatures. Top row 29°C, second row 18°C, third row 6°C and bottom row 3°C.*

Analysis of evidence [5–6] **thorough identification of relevant trends, patterns or relationships** The response identifies trends, patterns or relationships that are applicable to the research question.	Table 3, 4 and figure 2 display the qualitative data collected on colour and other observations of the capsicums, which all show a decrease in the quality as temperatures warm. All capsicums darkened from initial colour, showing the capsicums matured. The darkest colours occurred for the three capsicums in 29°C which significantly decreased in visual appearance and quality, by wrinkling of the outer skin and developing mould spots on the surface. This proves that capsicums cannot be stored at 29°C. The 18°C capsicums also depreciated in quality, by becoming slightly soft and wrinkled by 14 days. The highest quality capsicums were in the 3°C and 6°C, as they were firm for the whole of the trial, except for the 6°C capsicums which began going soft by 14-days, however both were better temperatures compared to 29°C and 18°C. **Evaluation:** **Reliability:** Low standard deviation suggests that the data collected is very reliable, however slightly decreasing in preciseness as temperatures cool which may be due to sources of error including: – The fridge temperatures (3°C and 6°C conditions) were variable (see appendix 5) however, stayed within a range. This may have caused the capsicums to hold or loose mass faster than a controlled temperature. – The anomaly of the 18°C at 5 days may have been due to the variable temperatures of the fume duct that was exposed to outdoor temperatures.
Analysis of evidence [5–6] **thorough and appropriate identification of the uncertainty and limitations of evidence** The response identifies the limitations of the evidence. This allows decisions to be made about the application of the evidence to the research question.	– Electronic scales may not be as accurate as possible, hence the ±0.01% in the data which may be more evident in smaller mass changes. – Data collection intervals were not in even (5,8,12,14 days), so could have skewed the data slightly. **Validity:** Very low standard errors in the data show that the data has a high accuracy and therefore is valid. Though some reliability issues occurred, these issues are also valid in the real world.
Interpretation and evaluation [5–6] **justified discussion of the reliability and validity of the experimental process** The response uses sound reasons and evidence to support a conclusion that directly responds to the research question.	– The constant light in the 29°C conditions may have affected the mass loss of the capsicums. The other conditions also had variable light (fume duct regular light/darkness; fridges constant dark), however as the standard error was low it is unlikely that this impacted the results. – The lighting in photographs were different initially to the final photos taken as it was difficult to photograph wrinkled capsicums without light reflecting, so colours may be different to real life. However, as the majority darkened as expected, the photos are relatively reliable. – Converting the raw mass data into the percentage change increased the validity significantly as all capsicums had different

Interpretation and evaluation [5–6] **justified conclusion/s linked to the research question** The response uses sound reasoning and evidence from the identification of uncertainties and limitations to support the consideration of the reliability and validity of the experimental process.	initial weights, so therefore the raw data could not have shown a clear conclusion. **Conclusion:** The most suitable temperature for capsicum annum is 3°C. According to the qualitative and quantative data collected, this condition ensured high post-harvest quality and a decent shelf life of 14-days (on average 3.82% mass loss). Low standard deviation and standard error for all conditions, except for an anomaly and small growth trends, proved that the data was accurate and precise. The colour of the capsicums darkened over time and the observations show that warmer temperatures (18°C and 29°C) will degrade quality quicker than cooler temperatures. The 6°C condition kept the capsicums at a high quality, however mass was lost at a faster rate than the 3°C conditions. To reduce wastage in the capsicum industry post-harvest, it is important to refrigerate capsicums at this optimum condition.
Interpretation and evaluation [5–6] **suggested improvements and extensions to the experiment that are logically derived from the analysis of evidence** The suggested modifications address the limitations of the experiment.	**Suggested improvements and Extensions:** **Improvements:** – Measure the capsicums mass at regular intervals (every 2-days) to improve reliability. – Use a consistent light source to take photographs as well as controlled light during the experiment in all conditions. – Utilise more consistent temperatures for 18°C and fridge conditions to increase reliability. **Extensions:** – Compare green and red capsicums in terms of colour to find any difference to results, like in secondary data. – Extend the experimental period to find how long it takes for capsicums to go soft in fridge conditions. – Add more specific temperatures around 3°C, like 0°C, 1°C, 2°C, to see what the optimal temperature for post-harvest storage is.
Communication [2] **acknowledgment of sources of information through appropriate use of referencing conventions** The sources of information are acknowledged using a referencing style that is suitable for the purpose of the scientific report.	**References:** Larissa. (2020). Food waste: Preventing a multi-billion dollar problem. *Curious*. Retrieved from https://www.science.org.au/curious/earth-environment/food-waste-preventing-multi-billion-dollar-problem Fight Food Waste. (n.d.). Transformation of surplus/waste tomato and capsicum produce into value-added products (stage one) | fight food waste crc. Retrieved from https://fightfoodwastecrc.com.au/project/tomato_capsicum/ Figure 1 – Ekman, Jenny; Goldwater, Adam; Winley, Emma (2016), Postharvest management of vegetables: Australian supply chain handbook PDF. Horticulture Innovation Australia. Retrieved from https://www.postharvest.net.au/

Capsicum production and growth in Australia during 2019. (2020). Retrieved from https://www.orchardtech.com.au/capsicums-production-in-australia-2019/

Scott Trimble. (2019). The path to reducing fresh produce losses in harvest & post-harvest | tools for applied food science | felixinstruments.com. Retrieved from https://felixinstruments.com/blog/the-path- to-reducing-fresh-produce-losses-in-harvest-post-harvest/

Appendix:

Appendix 1: Modified Method

Set up fridges to the set temperatures (6 and 3°C) and two areas that are around 18 and 29°C.
Put 3 red capsicums on a chopping board. Mark one area of about a 50 cent coin on each with a marker pen. Place under a uniform light and take a photo of each capsicum. A piece of paper on board may help to remember what temperatures they are in.
Weigh each capsicum and record all masses. Put these capsicums in the fridge.
Repeat step 2 and 3 for the remaining capsicums. There should be three capsicums in each temperature.
Use photoshop to work out the RBY of each capsicum and place this colour in a word document results table to compare initial and final colours of capsicums at the end of trial.
Weigh each capsicum at regular intervals (every 2-3 days).
Regularly check that the temperatures are correct (using a thermometer) in each fridge at regular intervals in the trial. Adjust if necessary.
At the end of 14 days take photos of and weigh each capsicum individually for the last time and record results.
Work out colour number and convert masses to percentages to find results.

Appendix 2: Original Experiment

Use one apple to perform the starch test (see below for instructions).

Then measure the mass, observe the colour by taking a photo and measuring the colour in RGB using

	Photoshop, of each apple before placing one on the bench at room temperature, one in plastic packaging, and one in a 4°CC fridge. Perform the same initial observations with the broccoli samples (except the starch test) and place them into the same conditions. Perform the same initial observations with the strawberry samples (except the starch test) and place 3 strawberries into each of the same conditions. Use one banana to perform the starch test (see below for instructions). Perform the same initial observations with the banana samples (including the starch test) and place 1 banana into each of the same conditions. Make the following iodine stain solution: Safety note: Use appropriate care when handling the iodine solutions. Use the graduated cylinder to measure 455 mL of the 2% potassium iodide (KI) solution. Carefully pour into the 1 L bottle. Use the graduated cylinder to measure 120 mL of the 2% iodine (I) solution. Carefully pour into the 1 L bottle. Add water to make 1 L (about 425 mL). Cap bottle securely and invert several times to mix. The solution will keep for long periods of time in a tightly covered brown glass bottle. Stain the fruit: CAUTION: Be careful with this solution. It will stain your skin and clothing if spilled. Wear protective gloves, eyewear, and a lab coat when handling the staining solution. Read and follow the safety note (step 7). Pour the iodine stain solution into the glass or plastic tray to a depth of 0.5 cm. Cut the pear (apple) in half (in cross section). Place the cut face of the fruit into the stain. You may want to prevent the cut surface from adhering to the tray bottom by propping it using glass rods or plastic straws. Let the fruit soak in the stain for one minute. Take the fruit out and rinse the face with water. (Rinse away from the staining tray so that the rinse water does not dilute the stain.) Note: the staining solution can be poured back into its storage container and used again for a future experiment. Use a funnel and pour carefully!

Quantify the staining:

a. Determine a numeric ripeness score by comparing your apples with the Ripeness Chart.

Appendix 3: Full Risk Assessment

RISK ASSESSMENT

Post Harvest Handling of Capsicums

Classes for which experiment is required

Items to be prepared by laboratory technician (training code 2)

9 x Red Capsicums
1 x black marker
2 x fridges (one 4 degrees, one 12 degrees)
3 x cutting boards
1 x camera (phone)
1 x light that will be the same beginning and end of experiment to make sure colours will be the same in photos
1 x weighing scales

Procedure or reference, including variations

1. Set up fridges to the set temperatures (4, 12, 25 degrees).
2. Put 3 red capsicums on a chopping board. Mark one area of about a 50 cent coin on each with a marker pen. Place under a uniform light and take a photo of each capsicum. A piece of paper on board may help to remember what temperatures they are in.
3. Weigh each capsicum ad record all weights. Put these capsicums in the fridge.
4. Repeat step 2 and 3 for the remaining capsicums. There should be three capsicums in each temperature.
5. Use photoshop to work out the RBY of each capsicum and place this colour in a word document results table to compare initial and final colours of capsicums at the end of trial.
6. Weigh each capsicum at regular intervals (every 2-3 days).
7. Regularly check that the temperatures are correct (using a thermometer) in each fridge at regular intervals in the trial. Adjust if necessary.
8. At the end of 10 days take photos of and weigh each capsicum individually for the last time and record results.
9. Work out colour number and average the weights to find results.

Equipment to be used

electronic balance

Potential hazards	*Standard handling procedures*
Can be knocked off bench, with potential injury to feet. Keep back from edge of bench. Danger of electrocution in wet areas or if wiring is defective.	Keep clean and tidy; remove spilled chemicals immediately. Check wiring for damage each time before use. Test and tag at regular intervals.

digital camera

Standard handling procedures
Fragile. Store in secure location to avoid theft.

chopping board, plastic

Potential hazards	*Standard handling procedures*
Flammable. Emits toxic fumes when heated or burnt.	Less porous than a wooden board, so suitable for biological materials, since cleaning is easier. Do not place hot objects on plastic chopping board, since plastic will melt and emit fumes.

indoor plant growing light

Standard handling procedures
Test and tag at regular intervals.

marker pen (permanent marker)

Potential hazards	*Standard handling procedures*
Inhaling the contents may be harmful, due to toxic volatile solvents. May cause severe irritation, if used on skin as a cosmetic. An allergic reaction is possible. Pen liquid may be flammable.	Recap tightly after use. Do not allow students to inhale fumes. Consult the safety data sheet from the manufacturer before use.

refrigerator (fridge)

Potential hazards	*Standard handling procedures*

Do not store flammable liquids in a refrigerator that is not specially designed and certified for storage of flammable liquids. Explosive air/vapour may detonate or catch fire when thermostat sparks or when door is opened and the door switch sparks. Fingers may stick to cooling coils when fridge is turned on immediately after defrosting. Danger of electrocution, especially in wet areas or if wiring is defective.	Check for electrical safety and test and tag at regular intervals.

Biologicals and food to be used

capsicum (Capsicum annuum, bell pepper)	
Potential hazards ALLERGY ALERT. Some individuals may be allergic to capsicum.	*Standard handling procedures* Do not eat in class, due to the possibility of contamination.

Knowledge

I/we have read and understood the potential hazards and standard handling procedures of all the equipment, chemicals and biological items, including living organisms.

I/we have read and understood the Safety Data Sheets for all hazardous chemicals used in the experiment.

I/we have copies of the Safety Data Sheets of all the hazardous chemicals available in or near the laboratory.

Agreement by student(s)

Risk assessment

I/we have considered the risks of:

fire or explosion	breakage of equipment	exposure to pathogens	waste disposal
chemicals in eyes	injuries from equipment	injuries from animals	improper labelling/storage
inhalation of gas/dust	rotating equipment	intense light/lasers	inappropriate behaviour
chemicals on skin	electrical shock	UV, IR, nuclear radiation	communication issues
ingestion of chemicals	vibration or noise	pressure inside equipment	allergies
runaway reaction	sharp objects	heavy lifting	special needs
heat or cold	falling or flying objects	slipping, tripping, falling	other risks

Assessment by Student(s)

I/we have assessed the risks associated with performing this experiment in the classroom on the basis of likelihood and consequences using the School's risk matrix, according to International Organization for Standardization Standard ISO 31000:2018.

I/we consider the inherent level of risk (risk level without control measures) to be:

Low risk Medium risk High risk Extreme risk

Risks will therefore be managed by routine procedures in the classroom.

Appendix 4: Raw data collected

	QUANTATIVE DATA – Masses (g)				
Capsicums & Temperatures	Day 0	Day 5	Day 8	Day 12	Day 14
30a	196.66	168.3	152.94	132.02	121.04
30b	221.95	188.22	170.84	151.11	141.93
30c	281.06	245.65	226.01	199.74	185.13
3a	215.76	211.13	209.21	205.93	204.41
3b	231.86	228.39	226.32	224.16	223.08
3c	245.78	243.23	242.20	240.56	239.84
6a	273.14	267.34	264.13	259.48	257.59
6b	190.03	184.6	181.55	176.93	175.23
6c	183.65	176.62	172.95	168.49	166.14
18a	174.47	161.1	154.95	149.54	146.46
18b	250.59	232.93	225.09	217.8	214.20
18c	268.49	238.1	239.44	230.86	226.64

Appendix 5: recorded temperatures

temperature							
1.Lamp	29	26					
4.Fume Duct	18	17.9	17.4	18.8	18.5		
2.Fridge a	1.2	4.8	5.8	5.2	4.0	2.2	3.1
3.Fridge b	7.2	6.4	6.3	6.4			