EFFECT OF STORAGE CONDITIONS ON THE PHYSICOCHEMICAL AND PROCESSING QUALITIES OF DIFFERENT POTATO GENOTYPES GROWN IN EASTERN UGANDA

ABSTRACT

The favourable environment in Eastern Uganda enables the growth of *Solanum tuberosum*, however, it's limited by lack of improved genotypes and inappropriate storage facilities. To address this, new potato genotypes including four CIP clones and four varieties from other regions were introduced by development partners. They also constructed ambient storage structures in Kapchorwa Municipality (1,800 m), Bennet (2,300 m), and Mbale City (1,200 m). This study was therefore designed to investigate the effectiveness of the ambient stores in maintaining the quality of the potato genotypes. During the study, the mean storage temperature ranged from 15.42 ^{o}C in Bennet to 22.80 ^{o}C in Mbale while the mean relative humidity ranged from 84.73% in Bennet to 79.58% in Mbale. The results showed significant ($P< 0.05$) differences due to variety. Storage duration and conditions led to a significant ($P< 0.05$) decline in the desired physiochemical characteristics and processing qualities of the stored potato genotypes.Potato genotype Victoria had the highest level of reducing sugars (0.08%) and least acceptable chip colour while Rwangume had the lowest reducing sugars (0.05%) and a more acceptable chip colour. In general, altitude and potato genotype influenced changes in the physicochemical and processing qualities of the potato genotypes during storage.

Keywords: Potato genotypes, C.I.P clones, Physicochemical properties and Processing qualities

INTRODUCTION

In Uganda,potato is grown for both home consumption and income generation, especially in the highland areas of South Western Uganda (Kabale and Kisoro) and the Eastern districts of Mbale

and Sironko[5,20].Potato production has also expanded to low-altitude areas in Uganda due to the introduction of low-land varieties [20].Potato production in Uganda is estimated at 162,151 metric tonnes with a rapidly growing demand for potato and its products[14].

The quality of potato tubers is closely linked to the chemical characteristics of the tubers and it varies widely in relation to different factors such as growing conditions, variety, harvest timeand means of storage [8,22].Eastern Uganda is however characterized by poor pre-storage and in-storage practices for potato. Potato is mainly stored in the kitchen, dark rooms, granaries covered with mud, old rudimental stores, on the floor of mud houses, cribs made from local materials, wooden purlins and covering with tarpaulins which leads to rapid potato deterioration[2,18]. This compels farmers to sell about 95% of the potatoes produced as fresh tubers immediately after harvest at very low prices[23]. As a result, there is a short supply of potatoes during the growing season[23]. The intermittent supply causes price fluctuations which have a negative impact on the incomes of the farmers as well as traders and consumers[23].

To address the challenges associated with the storage of potatoes, development partners in collaboration with different communities in Eastern Uganda constructed improved ambient stores at different altitudes in Mbale City, Kapchorwa Municipality and Kween districtand also introduced potato genotypes including CIP clonesunder development (392797.22, 398208.704, 393079.4, 393385.39) and existing varieties from other regions (Kingi, Victoria, Rwangume and Rwanshaka) for trial in the Eastern region of Uganda. However, no studies had been done to evaluate the efficiency of the improved storage structures with respect to maintaining the quality of potatoes in Eastern Uganda.This study hence evaluated the existing potato varieties and CIP clones for physiochemical properties and processing qualities under different storage conditions.
This study was thus seeking to answer the following questions:

1. What are the effects of storage conditions on the physicochemical properties of the stored potato genotypes?
2. What are the effects of storage conditions on the processing qualities of the stored potato genotypes?

MATERIALS AND METHODS

Study area

The study was conducted in Mbale City, Kapchorwa Municipality and Kween district in Eastern Uganda. The study areas were selected purposively for being the major potato-producing areas and selling points for potato in Eastern Uganda[25].

Table 1: Showing the study area and altitude

Study area	Ambient Store Location	Altitude
Kween	Bennet	2,300 m
Kapchorwa	Kapchorwa Municipality	1,800 m
Mbale	Mbale City	1,200 m

Research design

The study was a complete randomdesign involving the storage of eight potato genotypes in ambient stores at each of the study sites. Eight potato genotypes including four C.I.P clones under development for release namely; 392797.22, 398208.704, 393079.4, 393385.39 and four already existing varieties which included Kingi, Victoria, Rwangume and Rwanshaka were stored and evaluated. Evaluations were done four times starting with day one and every after 3 weeks of storage for a period of 9 weeks.

Potato tuber acquisition and storage

Potato tubers for storage were obtained from Buginyanya Zonal Agricultural Research and Development Institute (BUGIZARDI). The tubers were planted in February 2016, harvested in June 2016 and stored for 9 weeks. 120 tubers of each potato genotype were packaged in labellednylon mesh storage sacksfor carrying out quality tests. The potato tubers were stored in triplicates of 40 tubers for 9 weeks in filled ambient storage structures (Figure 1) located in each of the study sites. The ambient storage structures were constructed using bales of dried grass stacked together to form the walls which were later plastered with a thin layer of cement on the inner and outer surfaces. The storage structures were roofed with iron sheets mounted on wooden poles and were designed to keep light away. The ambient stores had a dorm-shaped structure with the width decreasing from one end to the other. The structure was also fitted with an exhaust fan which constantly sucked warm air from the ambient stores creating a cooling

effect.The ambient stores had hobos (model UX 100-003) fixed inside them to record internal temperature and relative humidity.

Figure 1: Ambient storage structure

Evaluating tubers under storage

Quality tests

This involved random picking of potato tubers without replacement. Six tubers per potato genotype and per replication were randomly picked from the ambient stores on day one and every after three weeks of storage for a period of nine weeks for carrying out quality tests including determination of dry matter content, pH and reducing sugar content of the tubers. Processing quality aspects including chip colour, chip texture, chip oil uptake and chip moisture content were also determined.

Physiochemical and sprouting properties

Dry matter content was determined by drying triplicate 5.0 g samples at 75^{o}C for 16 hours using the air oven as described by AOAC [3].The pH of potatoes was determined using the pH meteras described by AOAC [3].Reducing sugars were determined using the phenol sulphuric acid method according to Pomeranz and Meloan[21].

Chip Processing

Potato chips were prepared following a method descried by Kabira[13]. Potato tubers were washed and then peeled. The peeled tubers were cut into thin uniform chips of 1.2-1.3 mm thick using a potato chipper. The chips were washed under running tap water to remove adhering

starch and dried superficially with a towel. The chips were fried in fresh vegetable oil at 180 ^{o}C in a double deep fat fryer (Saachi model NL-DF-4758)for about 4 to 6 minutes until they turned crispy. The texture of the chips was determined using the penetrometer model FT 327 (3 – 27 Lbs).The chipswere placed on a hollow planar base and force was applied to the samples until the samples were broken.Chip colour was determined using the potato chip standard colour chart (Potato Chips/Snack Food Association (PC/SFA) colour card system [6]. The PC/SFA colour card system ranges from 1 to 5 where 1(light cream) denotes low sugar levels (acceptable), 2 (light tan), 3 (dark tan), 4 (brown) and 5 (very dark brown) denotes very high sugar levels (highly unacceptable) [2]. Chip oil uptake (COU) in different samples was determined by the Soxhlet extraction method [4].Chip moisture content was determined in a forced air oven as described by AOAC [3].

Data analysis

Data was analyzed using analysis of variance (ANOVA) with SPSS Statistical software version 19 and the means compared using LSD at 5% level of significance. Pearson correlation analysis was used to determine linear relationships between the parameters under study.

RESULTS

Storage conditions of the ambient stores

There was a general increase in relative humidity within the ambient structures at all the three study sites with increased storage time (Table 2). The ambient structures at Bennet and Kapchorwa recorded the highest mean relative humidity of 84.73% and 84.53% respectively while the ambient store at Mbale recorded the lowest mean relative humidity of 79.53% (Table 2). There was no significant ($p \leq 0.05$) difference in relative humidity within the ambient stores in Bennet and Kapchorwa.The ambient temperatures significantly ($p \leq 0.05$) differed from one ambient store to another (Table 2) withBennet recording the lowest mean temperatures (15.5^{o}C) and Mbale recording the highest mean temperature(22.79%).

Table 2: Temperature and relative humidity variation at different storage sites over the storage period

	Ambient Store	Week0	Week3	Week6	Week9
Relative Humidity	Bennet	80.01 ± 1.02 a	84.13± 1.15 a	86.51± 0.90 a	88.27± 0.68 a
	Kapchorwa	80.67 ± 1.32a	86.07± 0.86 a	87.37± 0.25a	83.99± 1.13 b
	Mbale	77.97 ± 0.77a	78.77± 0.90 b	79.97± 0.51b	81.60± 0.71c
Temperature	Bennet	15.53 ± 0.37 a	15.82± 0.05a	15.27± 0.39 a	15.05± 0.15 a
	Kapchorwa	18.93 ± 0.34 b	18.65± 0.11b	18.40± 0.08 b	18.43± 0.07 b
	Mbale	23.01 ± 0.48 c	23.23± 0.43 c	22.63± 0.48 c	22.30± 0.86 c

Values are mean ± SD and mean values followed by the same letters in a column are not significantly different at 5% level of significance.

Physicochemical properties of potatoes during storage

The physicochemical properties of the stored potato genotypes are given in Table 3.

Table 3a: Variation in the physicochemical properties of the stored potato genotypes

Genotype	Dry Matter content (%)	Reducing sugars (%)	pH
392797.22	19.83 ± 0.62 d	0.06 ± 0.03 b	6.16 ± 0.02 b
393079.4	20.31 ± 0.69 c	0.05 ± 0.03b c	6.25 ± 0.12 a
393385.39	20.80 ± 0.86 b	0.06 ± 0.04b c	6.12 ± 0.04 bc
398208.704	21.85 ± 0.63 a	0.07 ± 0.03 ab	6.10 ± 0.05 c
Kinigi	19.90 ± 0.79 d	0.06 ± 0.03 bc	6.25 ± 0.06 a
Rwangume	20.02 ± 0.46 cd	0.05 ± 0.04 c	6.13 ± 0.05 bc
Rwanshaka	18.58 ± 0.61 f	0.05 ± 0.02 c	6.24 ± 0.06 a
Victoria	19.28 ± 0.57 e	0.08 ± 0.03 a	6.00 ± 0.04 d

Values are mean ± SD and mean values followed by the same letters in a column are not significantly different at 5% level of significance.

Table 3b: Effect of storage conditions on the physiochemical properties of the stored potato genotypes

Ambient store	Storage time	Dry matter content (%)	Reducing sugars (%)	pH
Bennet	week0	21.13 ± 1.26 a	0.01 ± 0.01 a	6.07±0.11 a
	week3	21.01 ± 1.21 b	0.04 ± 0.03 b	6.21±0.17 a
	week6	19.61 ± 0.98 a	0.08 ± 0.04 ba	6.18 ±0.12ab
	week9	18.70 ± 1.02 a	0.09 ± 0.05 b	6.15 ±0 .09 a
Kapchorwa	week0	21.13 ± 1.26 a	0.01 ± 0.01 a	6.07 ± 0.11 a
	week3	21.18 ± 1.39 b	0.05 ± 0.02 b	6.26 ± 0.16 a
	week6	19.56 ± 1.41 a	0.05 ± 0.04 b	6.16 ± 0.08 b
	week9	18.50 ± 1.23 a	0.07 ± 0.07 b	6.20 ± 0.13 a
Mbale	week0	21.13 ± 1.26 a	0.01 ± 0.01 a	6.07 ± 0.11 a
	week3	21.68 ± 1.17 a	0.10 ± 0.04 a	6.15 ± 0.10 b
	week6	19.20 ± 1.24 a	0.09 ± 0.03 a	6.22 ± 0.09 a
	week9	17.94 ± 1.16 b	0.11 ± 0.04 a	6.14 ± 0.14 a

Values are mean ± SD and mean values followed by the same letters in a column are not significantly different at 5% level of significance.Means of different stores are compared per week.

Table 3c: Correlation between the physiochemical properties of the stored potato genotypes

Dry matter	**Dry Matter**		
pH	-0.1521	**pH**	
Reducing sugars	0.2422	-0.4991**	**Reducing Sugars**

** shows strong correlation * shows a weak correlation

Dry matter content

The effect of storage conditions and genotypic make-up significantly ($p \leq 0.05$) influenced tuber dry matter content (Table 3a and b). The highest mean percentage dry matter content was obtained in potato genotype 398208.704 (21.85%) while the lowest was recorded in Rwanshaka (18.58%) in all the ambient stores during the study time (Table 3a). Percentage dry matter content of the potato genotypes was fairly constant in the first 3 weeks of storage followed by a significant ($p \leq 0.05$) decrease in week 6 and week 9 in all the ambient stores.

pH

pH levels showed variable trends under different storage conditions with an initial increase followed by a general decline. For all the genotypes, pH ranged between6.00 to 6.25. The highest mean pH levels were recorded in genotype 393079.4 (6.25) and Kinigi (6.25) while the lowest were in Victoria (6.00) in all the ambient stores (Table 3a). There were no significant ($p \leq 0.05$) differences in pH of the potato genotypes within the stores (Table 3b).

Reducing sugars

The reducing sugar content of the potato genotypes increased with storage time in all the ambient stores (Table 3b). The ambient store in Mbale had potato genotypes with the highest level of reducing sugars as compared to Bennet and Kapchorwa. There was no significant ($p \leq 0.05$) difference in reducing sugar content of the potato genotypes in Bennet and Kapchorwa.The highest mean percentage reducing sugars were recorded in potato genotypes 398208.704 (0.07%) and Victoria (0.08%) while the lowest mean reducing sugars were recorded in Rwanshaka (0.05%) in all the ambient stores (Table 3a).

Processing Quality

The processing qualities of the stored potato genotypes are given in Table 4.

Table: 4a: Variation in processing qualities of the stored potato genotypes

Potato Genotypes	Colour	Texture (N)	Chip oil uptake (%)	Chip moisture content (%)
392797.22	2.00 ± 0.72 e	7.2 ± 0.08 d	40.55 ± 0.81ab	3.54 ± 0.49 d
393079.4	2.67 ± 0.75b c	7.8 ± 0.11 c	38.88 ± 1.75 bc	4.71 ± 0.75 bc
393385.39	2.80 ± 0.60 b	8.5 ± 0.14 b	36.39 ± 2.73 d	4.41 ± 0.47 c
398208.704	3.97 ± 0.55 a	9.4 ± 0.13 a	39.73 ± 1.20 abc	3.84 ± 0.67 d
Kinigi	2.45 ± 0.63 cd	6.2 ± 0.09 e	38.39 ± 1.07 c	4.84 ± 0.55 bc
Rwangume	2.16 ± 0.64 e	7.3 ± 0.07 cd	38.22 ± 2.62 c	4.85 ± 0.49 b
Rwanshaka	2.19 ± 0.71d e	5.9 ± 0.09 e	40.34 ± 1.91 ab	4.53 ± 0.74 c
Victoria	3.75 ± 0.71 a	7.1 ± 0.08 d	40.99 ± 0.58 a	5.33 ± 0.39 a

Values are mean ± SD and mean values followed by the same letters in a column are not significantly different at 5% level of significance.

Table 4b: Effect of storage conditions on the processing qualities of the stored potato genotypes

Ambient store	Storage time	Colour	Texture (N)	Chip oil uptake (%)	Chip moisture content (%)
Bennet	week0	1.83 ± 0.70 a	7.7 ± 0.10 a	36.74 ± 6.96 a	4.01 ± 1.08 a
	week3	2.58 ± 0.83 b	8.2 ± 0.16 a	39.86 ± 2.73 a	4.13 ± 1.03 a
	week6	3.21 ± 0.98 a	7.4 ± 0.22 a	39.32 ± 4.30 a	4.50 ± 0.90 a
	week9	3.25 ± 1.03 a	5.8 ± 0.14 b	41.47 ± 4.02 a	5.20 ± 0.69 b
Kapchorwa	week0	1.83 ± 0.72 a	7.7 ± 0.10 a	36.74 ± 6.96 a	4.01 ± 1.08 a
	week3	2.95 ± 1.27a	8.5 ± 0.21 a	38.78 ± 4.41 a	3.86 ± 0.95 b
	week6	2.70 ± 1.05 b	7.4 ± 0.21 a	39.37 ± 4.12 a	4.49 ± 1.23 b

	week9	3.04 ± 1.20 ab	6.6 ± 0.16 a	41.98 ± 4.63 a	4.88 ± 1.04 b
Mbale	week0	1.83 ± 0.70 a	7.7 ± 0.10 a	36.74 ± 6.96 a	4.01 ± 1.08 a
	week3	3.17 ±1.31 a	8.8 ± 0.20 a	38.99 ± 4.57 a	3.77 ± 0.86 b
	week6	3.08 ± 1.32 a	6.5 ± 0.21b	40.89 ± 3.93 a	5.23 ± 1.78 b
	week9	2.78 ± 0.86 b	6.7 ± 0.12a	42.75 ± 4.48 a	6.36 ± 1.51 a

Values are mean ± SD and mean values followed by the same letters in a column are not significantly different at 5% level of significance.Means of different stores are compared.

Table 5: showing correlation between physiochemical parameters and processing quality

	Dry matter Content	Reducing Sugars	pH	Chip Colour	Chip texture	Chip Oil uptake	Chip moisture content
Dry matter Content							
Reducing Sugars	0.2422						
pH	-0.1521	-0.4991**					
Chip Colour	0.4248*	0.6882**	-0.6397**				
Chip texture	0.8773**	0.3061	-0.2963	0.4899*			
Chip Oil uptake	-0.3244	0.1268	-0.1121	0.0181	-0.2147		
Chip moisture content	-0.3808	0.2516	0.1442	0.1385	-0.3339	-0.0793	

** shows strong correlation * shows a weak correlation

Chip texture

The results presented in Table 4a indicate that the highest mean chip texture was recorded in potato genotypes 398208.704 (9.4N) and 393385.39 (8.5N) while the lowest mean chip texture was recorded in Rwanshaka (5.9N) in all the ambient stores during the study time (Table 4a).The chip texture of the stored potato genotypes decreased with an increase in storage time (Table 4b).

Chip colour

Storage at all temperatures showed an increase in chip darkening, however the ambient store in Mbale had potato genotypes with the darkest chip colour with the increase in storage time as compared to other ambient stores (Table 4b). Table 4 a shows that the highest chip colour score (Poor score) was recorded in 398208.704 (3.95) while the lowest score (acceptable) was recorded in Rwangume (2.33) and 39279.22 (2.00) in all the ambient stores. There was an increase in chip darkening with an increase in storage time.

Chip oil uptake

There was a high significant ($p \leq 0.05$) difference in chip oil uptake among the stored potato genotypes but the storage environment did not significantly influence chip oil uptake (Table 3a and b). The highest mean percentage oil uptake was recorded in potato genotype Victoria (40.99%) while the lowest mean percentage oil uptake was recorded in Kinigi (38.39%) in all the ambient stores during the study time (Table 3a).

Chip moisture content

Table 3b shows that chip moisture content increased with an increase in storage time. The highest mean chip moisture content was recorded in Victoria (5.33%) and Rwanshaka (4.53%) while the lowest mean chip moisture content was recorded in 39297.22 (3.54%) (Table 3a).

DISCUSSION

Storage conditions

Temperature is likely to have been influenced by relative humidity. Higher relative humidity (84.73%) in Bennet was associated with lower ambient temperatures (15.42^{o}C) while the low relative humidity registered in Mbale (79.59 %) was associated with a slightly high temperature (22.79^{o}C) throughout the study time. Similar studies by Woodell [27].reported that small temperature changes can cause dramatic changes in relative humidity. The observed trends in ambient temperature and humidity could also be attributed to altitude. Both Bennet and Kapchorwa are at a much higher altitude (2,300 m and 1,800 m, respectively) than Mbale (1,200 m) and they recorded lower temperatures and high relative humidity. Thomas [24]. in his study also stated that high altitudes are associated with high relative humidity and low temperature. The ambient structures also had an influence on the temperature and relative humidity. The ambient stores had a dorm-shaped structure with the width decreasing from one end to the other which was fitted with an exhaust fan. The fan constantly sucked warm air from the ambient stores which caused a cooling effect. The ambient stores were also made of thick walls containing bales of dried grass plastered with a thin layer of cement which provided insulation against the external environment.

Dry matter content

The stored potato genotypes in all the ambient stores exhibited a general decrease in dry matter content. This decrease in dry matter content corresponds to the results of Davydenko[8]who reported a significant decreasing trend in the specific gravity and dry matter content of the potato tubers under storage.The variations observed show that potato dry matter content is likely to have been influenced by the genotypic make-up of the potato tubers as also reported in the studies by Mouhammed [19].The decrease in dry matter content with increased storage time could be attributed to the gradual respiratory biochemical starch breakdown to sugars that are used to maintain the life of the tuber with concurrent production of carbon dioxide and water vapour[7].The decrease in percentage dry matter content of the stored potato tubers may also have been due the slightly high temperatures (15.42 ^{o}C to 22.79^{o}C) recorded in all the ambient stores. The potato genotypes stored in the Mbale ambient store lost the greatest percentage of dry matter content in comparison to those stored in other ambient stores.The slightly higher mean temperatures (22.79^{o}C) in the Mbale ambient store in comparison to other ambient stores are likely to have led to a greater loss in percentage dry matter content.

Reducing sugars and pH

The stored potato genotypes recorded an increase in percentage reducing sugars in all the ambient stores with variations in each of the genotypes. The increase in reducing sugars during storage was also reported by Gikundi[10].The variation in percentage reducing sugars are likely to have been dependant on the genotypic make up of the stored potato tubers as also reported in the study by Khan[15].The increase in percentage reducing sugars of the stored potato genotypes is likely to have been due tostorage at slightly high temperatures in all the ambient stores (15.42 ^{o}C to 22.79 ^{o}C). The high temperatures increase the rate of respiration and also favour faster degradation of starch to more soluble sugars like glucose and fructose in a process known as senescent sweetening [11]. The higher percentage of reducing sugars recorded in potato genotypes stored in the Mbale ambient store than in other ambient stores is likely to have been due to its temperatures being slightly higher than that in other ambient stores in Kapchorwa and Bennet. pH generally ranged from 6.00 to 6.25. This is in agreement with the findings of

Kiszonas[16] who reported the pH of raw potatoes to range from 5.5 to 6.2. The increase in reducing sugars makes the potato juice more acidic due to the lactic acid produced in starch break down hence leading to a drop in pH [9]. This is also seen from the strong negative correlation (r = -0.5) between pH and reducing sugars.

Processing quality

The variations in processing qualities of the potato genotypescould have been dependent on the physicochemical properties and thegenotypic makeup[15]. The general decrease in chip texture, increase in chip oil uptake and chip moisture contentof the potato genotypes could have been dependent on tuber dry matter content. This is also seen from the strong positive correlation (r = 0.8773) obtained between dry matter content and chip texture during the study time and the negative correlation (R= -0.324) between chip oil uptake and dry matter content. The positive correlation between dry matter content and chip texture was also reported by Islam [12]. Chips prepared from tubers with a high dry matter content usually have hard textures and absorb less oil whereas those with low dry matter content are characterized by soft, sticky and greasy textures[12,19].

The increase in chip darkening of the stored potato genotypes with storage time is likely to have been dependent on the increase in reducing sugars. This is also seen from the strong positive correlation (r = 0.68) between chip colour and reducing sugars. Very high levels of reducing sugars result in production of dark brown chips which lowers consumer acceptance[12,15]. The reducing sugars react with free amino acids during high temperature cooking in the Maillard reaction leading to production of dark coloured chips.Li [17] also reported that reducing sugars can react with amino acids in the Maillard reaction leading to undesirable browning, production of bitter tasting dark coloured pigments (melanoids), the development of off-flavours and the production of toxic compounds such as acrylamide that reduce the acceptable consumer flavour.

Conclusion

The storage conditions and genotypic makeup significantly ($p \leq 0.05$) affected the physiochemical characteristics and processing qualities of the stored potato genotypes. The desired physiochemical characteristics and processing qualities of the stored potato genotypes

declined with increased storage time. Storage at higher temperatures (22.79 ^{o}C) resulted in the least acceptable processing qualities.The chips from potato genotype 392797.22, Kinigi and Rwangume were the most acceptable. Higher altitude is a better option than low altitude for long term storage of potato. It is therefore recommended that farmers using ambient stores in low altitude areas like Mbale should not store potato for more than 6 weeks or they should modify stores to lower the temperatures and place water management to improve the humidity. Potato genotypesRwangume, 392797.22 and Kinigi can be promoted as premium genotypes for the potato processing industry due to their good processing qualities.

Table 6: Showing the best and poor genotypes per study variable

Study variable	Best characteristics	Poor characteristics
Dry matter content	High dry matter content • 398208.704	Low dry matter content • Rwanshaka
Reducing sugars	Low reducing sugars • Rwanshaka	High reducing sugars • 398208.704 • Victoria
Chip colour	Good / acceptable • Rwangume • 392797.22	Low acceptability • Victoria • 398208.704
Chip texture	Good / acceptable • 398208.704 • 393385.39	Low acceptability • Rwanshaka
Chip oiliness	low oil uptake • Kinigi	High oil uptake • Victoria

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