REPORT

Consumer Demand and Preferences for Boiled Potato and Sweetpotato in Hanoi, Vietnam

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EXCUTIVE SUMMARY

Many new crop varieties developed by breeding programs are poorly accepted by consumers and processors, resulting in low levels of adoption. Recently, there is growing attention to understanding preferences of end-users specifically, the quality attributes they seek. Hence, in the framework of RTB CC.4.1. EAR project, this study was carried out to assess **Consumer demand and preferences for boiled potato and sweetpotato in Hanoi, Vietnam**.

Six sweetpotato varieties and ten potato varieties were evaluated by consumers in Hanoi, Vietnam. The set of varieties included popular market varieties and improved varieties provided by CIP.

Three main methods were used in this research:

1) Quantitative Descriptive Analysis (QDA): Its objective was to describe samples by sensory descriptors and to locate samples on a positioning map by a trained panel. There were 10 panelists (two men and eight women) in the panel. The panelists were HUST staff and lecturers, aged from 28 to 53 years, with previous experience in sensory evaluation.

2) Focus group Discussion (FGD): Its objective was to collect consumers 'opinions about consumption habit, most preferred characteristics and least preferred characteristics of sweetpotato and potato. Eight discussions were conducted with ten participants per session per products. The participants were urban consumers balanced by gender, age, and income level.

3) Consumer acceptability/preference test using a 7-point hedonic scale, Just-about-right scale (JAR) and Check-all-that-apply list (CATA): Its objective was to evaluate consumers' acceptance for each variety, and to understand why consumers liked or dislike a product. 160 (untrained) consumers (80 for sweetpotato and 80 for potato) were recruited from HUST network and database, balanced in age and gender.

The results obtained are presented in two parts:

Part 1: Results for sweetpotatoes

Firstly, results from the QDA permitted to describe all studied samples by 22 sensory descriptors. Basing on their sensory characteristic descriptors, samples were separated in four groups. In each group, they had similar sensory properties.

Group	Product	Characteristics
1	Beniazuma	[IN] Yellow-as-bean, [On hand] Dry, [Odor] Starch, [Flavor] Starch, [In-mouth] Throat-tightness, [In-mouth] Mealy.
2	Red_Hoang Long White_Hoang Long	[Peel] Yellow, [IN] Green yellow, [On hand] Smooth, [In-mouth] Smooth, [IN] Homogeneous
3	Khoai Mat China imported	[IN] Yellow-as-turmeric, [On hand] Sticky, [On hand] Soft, [On hand] Wet-pasty, [SF] Wet, [Odor] Honey, [Taste] Sweet
4	Khoai Bo	[IN] Yellow-as-turmeric, [Odor] Honey, [Peel] Red

Secondly, results from the FGD collected consumers' habit on usage of sweetpotatoes. Hanoi end-users preferred *Japanese and domestic purple varieties*. They often *boiled* and *grilled* sweetpotatoes, and consuming them *as snack*. The most important factor in product selection was *Quality*, followed by *Price*. The preferred sensory properties were *yellow inside*, *oblong shape, mealiness*, and *no strange characteristics* (ex: holes, black dots, cut/break...). The acceptable price was between 10000-20000 VND/kg. Otherwise, there were some different opionions depending on consumers' age, gender, and income levels.

Thirdly, results from the consumer test showed that the most preferred sample was Beniazuma, and the least preferred was White Hoang Long. This result was then combined with the QDA results by a preference mapping. In consequence, we could explain why consumers liked or disliked each product. And, we found that some descriptors correlated with liking scores, in positive way *([Peel]Red, [Peel]Brown, [In] Mealy)*, and in negative way *([In-Mouth] Soluble, [In-Mouth] Smooth, [Peel] Yellow, [In] Homogeneous)*.

JAR results suggested the way to improve samples' preferences. For Red Hoang Long and White Hoang Long varieties, *Yellow* and *Sweetness* need to be increase. However, for Beniazuma, *Softness* needs to be increased and *Sweetness* decreased. Penalty analysis of consumer data showed that sweetness and yellow (inside) were key drivers of overall liking.

Finally, CATA results explained better the hedonic test results by consumers' descriptions. Beniazuma was always the most preferred sample because it was : *Crumbly, Starchy-smell, Fine-surface, Comfort-smell (familiar, natural), Starchy-taste, Brown-peel, Easy to eat, Delicious*.

This study identified the priority characteristics which Hanoi users prefer for selecting roots for boiled sweetpotato.

Part 2: Results for potatoes

Similarly with the results of part 1, we found some important results for potato varieties as follows.

Firstly, results from the QDA enabled description of all studied samples using 36 sensory descriptors. Based on their sensory characteristic descriptors, samples were separated in to five groups according to their characteristic descriptors.

Group	Products	Typical characteristics
1 (F1-2)	Solara, KT1	T_Sweet, ST_Fine, IN_Yellow, SK_Fine, ST_Soluble, SK_Yellow
2 (F1-2)	KT6, KT4	ST_Liquid, ST_Soft, ST_Homogenous, SF_Fine, SF_Shine
3 (F1-2)	No.3	ST_Uncooked, IN_White, SK_Brown, T_Greasy, O_Immature
4 (F1-2)	Marabell. KT5	IN_Yellow green, ST_Farine, O_Starch, SF_Dry, SF_Floury, T_Umami
5 (F1-3)	No.1, No.10	SK_Fine, ST_Uncooked, IN_Yellow, SK_Brown, ST_Sticky

Secondly, results from the FGD collected consumers' habits on used of potatoes. Hanoi end-users often *made a soup (with pork bone, curry) and fried potatoes*, and consuming these tubes in the main meals*.* The most important factor in product selection was *Price* and the followed by *Origin (Local origin is the most preferred, and Chinese one is the least preferred)*. The preferred sensory properties were *yellow inside*, *bold and medium size, firmness*, and *no green color*. The acceptable price should be between 10.000-20.000 VND/kg. Otherwise, there were some minor different opionions depending on consumers' age, gender, and income levels.

Thirdly, results from the consumer test showed that the most preferred samples were KT5 (CIP) and Marabell, and the least preferred ones were No1, No2, No3. This result was then combined with the QDA results by a preference mapping as well. In consequence, we found the relationship between some sensory descriptors and liking scores, in positive way (*O_Cooked potato, IN_Green yellow, ST_Fine)*, and in negative way (*SF_Sticky, IN_Transparent, O_Rooted, O_Fresh potato, ST_Tender, SK_Red brown).*

JAR results suggested the way to improve the preferrences for each samples. There were a lot of descriptors whose intensity needed to be increased to improve hedonic scores such as; *Yellow, Smell, Soft, Wet, Farine, Sweet* for the least preferred sample No1.

Finally, CATA results explained better the hedonic test results by consumers' descriptions. The most preferred group, including KT1, KT4, Marabell, KT5 (CIP), Solara (CIP), was characterized by *fragrant, delicious, sweetpotato, powdery, easy to eat, natural, honey, even, sweet, eye-catching, yellow inside*. While the least preferred group, including No1, No3, No10, was characterized by *acid, dislike, tasteless, discomfort flavour*.

In brief, the obtained results achieved a more comprehensive understanding of consumer preferences for a range of product profiles. Hence, this is ultimately expected to contribute to a more targeted and demand-led breeding effort.

1. INTRODUCTION AND STUDY OBJECTIVES

1.1. Background and Purpose of Study

Many new crop varieties developed by breeding programs are poorly accepted by consumers and processors, resulting in low levels of adoption. Recently, there is growing attention to understanding preferences of end-users and the quality attributes they seek. changes in markets, new products, novel trait discovery and social context (e.g. urbanization) may all influence the end-users' preferences for foods over time. Roots, tubers and bananas (RTB crops) do not represent an exception. Information on gender disaggregated consumer preferences for RTB food products and varieties is limited and often not available to inform breeding programs; resulting in release of varieties that often do not meet end-user preferences.

The CGIAR Research Program on Roots, Tubers and Bananas (RTB) is addressing this challenge by implementing research on end-users preferences with bilateral funds such as the BMGF-funded RTBFoods project for a range of RTB crops (cassava, sweetpotato, yam, cooking banana/plantain and potato) and RTB-based food products (product profiles). RTB is also providing W1-W2 funding (CC.4.1 EAR) to complement activities conducted under RTBFoods with a focus on additional product profiles and countries, and by targeting urban rather than rural areas which have been the focus of RTBFoods. By doing so, it is expected that RTB CC.4.1. EAR will add value to RTBFoods and contribute to achieving a more comprehensive understanding of consumer preferences for a range

of product profiles. This is ultimately expected to contribute to a more targeted and demand-led breeding effort. In the framework of RTB CC.4.1. EAR, CIP is responsible to conduct research on consumer profiles of potato and sweetpotato in Uganda and Vietnam.

The purpose of this report is to present the key findings of a study that assessed **Consumer demand and preferences for boiled potato and sweetpotato in Hanoi, Vietnam**.

1.2. Main methods for assessing consumer preferences

Several methods can be used to assess end-user preferences for fresh crops and cooked foods. These include the following methods:

- Quantitative Descriptive Analysis (QDA)

- Focus Group discussion

- Individual Questionnaire

- Consumer Test

- Check-all-that-apply (CATA)

- Just-about-right (JAR)

1.2.1. Quantitative Descriptive Analysis (QDA)

Quantitative Descriptive Analysis (QDA) is one of main descriptive analysis techniques in sensory evaluation. This method was developed to deal with poor statistical treatment on data obtained by Flavour Profile and related descriptive methods.

The QDA methodology requires a panel with about 6 to 15 members. In this method, multiple product evaluations are suggested to capitalize on panellists' skills in making relative judgments with a high degree of precision. In general, it is more difficult for humans to evaluate the absolute sensory differences than the relative ones (Stone, 2004). This philosophy has made QDA methodology distinctly different from those descriptive methods which try to determine the absolute difference among products (e.g., Spectrum method).

Similarly, to other descriptive methods, subjects are screened based on their performance on discrimination tests and verbalization in the QDA methodology. Standards for subject qualification are arbitrary and may vary depending on the study. A panel of 6 to 15 members is recommended in QDA (Stone, 2004). During training, test

products are served as illustrative stimuli for the lexicon. The panel leader works as a communication facilitator without involvement and interference with panel discussions. References can be used for generating sensory terminologies, especially when panellists are confused and or disagree with each other on some sensory attributes during training sessions (Stone, 2004).

Line scales are employed for panel training and data collection in QDA®. This line scale is designed as 6-inch (=metric system equivalent) in length with sensory intensities word anchors located 0.5 inch from each end. The scale direction goes from left to right with increasing intensities, e.g., weak to strong, little to much. During data collection, panellists measure sensory intensities independently in individual booths without reference served as intensities standards. Panellists are allowed to use different parts of the scale to determine the sensory intensities by themselves. As a result, the difference among products produced by QDA will be a relative measurement; the importance of absolute scale value has been neglected (Lawless and Heymann, 1998). Subjects' reliability is evaluated by their repeated measurements on product attributes.

The results from QDA are informative for statistical practices to meet the study goal. Panel performance can be examined by interaction of product and panellist; product difference can be diagnosed by means of a one-way analysis of variances (ANOVA) based on attributes. Statistical procedures, such as multivariate analysis of variance, principal component analysis, factor analysis, cluster analysis can be widely applied to QDA dataset (Lawless and Heymann, 1998, Joel L. Sidel et al., 2018); allowing attributes in the same sensory category to be graphically presented by a "spider web".

1.2.2. Focus Group Discussions

To get an idea of what people think about boiled potato and sweetpotato and what comes into their mind when talking about the topic, initial focus group discussions can be conducted.

A focus group discussion is a qualitative consumer research method which can be used in product development and consumer preference studies for exploration of sensory vocabulary, for development of questionnaires or to create new ideas. Edmunds (1999) further mentions the technique as useful for assessment of product usability or the evaluation of advertisement or product positions.

An important advantage of qualitative methods is the in-depth interactions through interviews with or observations of respondents which provide the opportunity to evaluate samples in a less structured way than in a sensory research laboratory or through structured questionnaires. Furthermore, it is a good technique for probing underlying motivations, attitudes, beliefs, perceptions, opinions and personal ideas about a product.

With focus groups no statistical analysis is possible. Therefore, the analysis and reporting need to focus on and address the objectives of the study. Usually, the moderator writes the report. The number of participants varies from three up to twelve, depending on opinions of different researchers (Krueger et al., 2009, Kitzinger, 1995). Lawless and Heymann (2010), recommend about eight to twelve participants, who are pre-selected according to defined selection criteria. It is important that the size of the group is small enough to ensure contribution from all the participants but large enough to get different opinions and arguments across the topic (Krueger, 1998). Furthermore, participants should be like "strangers on a train" to each other to make sure that they can act uninhibited in the discussions. When recruiting, characteristics of participants like age, gender, ethnic and cultural differences as well as social status need to be taken under consideration and respected (Fern, 2001).

The fact that several people can be interviewed simultaneously makes the method inexpensive and fast. Another advantage of this technique is that several focus groups can be conducted in one study. In case of two groups conflicting with each other it is useful to conduct at least three focus group discussions to discover the one´s opinion that is more reasonable (Lawless and Heymann, 2010).

Usually, interviews can take place on a round table with comfortable chairs where consumers can sit around. The room should be neutral and non-distracting with sufficient lighting and ventilation. Participants are served with drinking water. A qualified moderator facilitates the process by asking questions or giving panellists discussion topics. Fern (2001) describes a moderator as a discussion leader who does not participate directly in the discussion. The moderator does not necessarily need to be a professional one but can be the researcher of the study. Generally, a moderator should refer to the discussion guide moving from general to more specific questions. Krueger (1998)

mentions the moderator as the person who is responsible for creating a conducive climate in which participants feel comfortable and confident to discuss openly.

As it is a flexible method, the content may change through interactions among participants although the interview should be focused on certain issues or products. The mentioned interaction among participants is the most important aspect of focus groups. Ideas that would not have been thought by some participants can be raised by others. According to Cardinal et al. (2003) the participants engage during the session which leads to a group dynamic where comments can stimulate the discussion. People who come to the fore should be slowed down and those who do not contribute should be encouraged to participate as well.

Another important part of a focus group discussion are the questions and the way they are asked within the discussion. Krueger (1998) recommends that questions are clear, short and reasonable to be effective. Furthermore, it is important that questions are formulated in an easy, natural language which is free of technical jargon. Participants need to understand those questions. Therefore, easy wording is recommended. Questions should be conversational and open ended to encourage a dynamic discussion and interaction among people. Moderators should avoid answering questions or parts of it because this can influence participants' thoughts and force the discussion direction.

Focus groups do have an asymptotic learning curve which means that most of the information can be obtained from the first few groups.

1.2.3. Individual Questionnaire

An individual questionnaire is one method of gaining information from consumers or experts in a sensory testing procedure. Self-administered questionnaires done by paper are inexpensive, but panellists cannot be controlled when working on the questionnaire. They can answer questions as they like which might not be the designed order, or they could read the entire set of questions before answering them. Furthermore, it can be the case that questionnaires are handed in incomplete, or panellists do get bored because of too many questions. Reasonable is a flow from general questions e.g., opinion or overall liking or acceptability of a product, to more specific questions like Just-about-right questions or intensity scales. Generally speaking, a 9-point hedonic scale can be used to test basic statements. Demographic information can be obtained from a questionnaire. In this case, questions about age, gender, family status or residence can be asked. Delicate

questions like the income level can be asked too but should be done in a sensitive way to give panellists a trusting and comfortable zone. Panellists should not get bored while answering the questions. Moreover, questions should not overlap each other, people can only be asked about topics they have knowledge about and they should not be lead. Before working with a questionnaire in real testing, pre-testing is necessary to prevent failure (Lawless and Heymann, 2010; Youngshin et al., 2015).

1.2.4. Consumer testing

Hedonic Scaling is a common tool of measuring hedonic experiences, consumer preference and acceptability in food science. Generally, scaling uses numbers for translating impulse responses to further quantify sensory experiences and perceptions. The process of responding to a stimulus is separated into biological and cognitive stages where sensory input is converted into a response. The 9-point hedonic scale is created as a bipolar scale with equal spacing between the centre point (as known as "neither like nor dislike"), and from "dislike extremely" to "like extremely" (Lawless and Heymann, 2010; Lim, 2011). Nicolas et al. (2010) reported that there is a difference in the rating between 9-point hedonic scales where only the numbers or only the words are presented to consumers. Panellists might use different cognitive strategies for these two scales. There is not only the 9-point hedonic scale but also the 5 or 7-point hedonic scale.

The broad usage of the scale in different fields of sensory testing is based on its limitation of choices which can ease the work of panellists as well as of researchers due to its categorical nature. Participants usually do not need time-consuming trainings to use this type of scale. However, the extreme end points, the lack of ratio properties and the missing zero-point stand for some disadvantages of this method. When working with such a scale, some effects of context, of sensory or perceptual properties as well as other sources of error need to be taken into account (Lawless and Heymann, 2010; Lim, 2011).

1.2.5. Check-all-that-apply (CATA)

Check-all-that-apply (CATA) questions can be used in consumer studies to reveal sensory characteristics of products by asking consumers how they observe specified sensory characteristics of food products (Lancaster et al., 2007). This way of testing can sometimes be more useful to explore consumers' relevant attributes and it might be less costly than asking trained assessors. Moreover, the trained panel's descriptions can differ

from the ones that consumers would use. Hence, with trained panels, there is a risk of creating consumer irrelevant descriptors (Kleij et al., 2003).

The characteristic trait of CATA is that test persons describe samples in kind of a free choice without scaling the parameter´s value. This means that they are allowed to choose every suitable characteristic given on a predefined list (Dooley et al., 2010).

Generally, CATA questionnaire is a simple way to get appropriate descriptions including emotions of consumers. To determine the relevant descriptors of each product, the frequency of checked descriptors is counted (Ares et al. 2013). A major advantage of CATA test is that no experienced or intensively trained participants is needed.

There are different ways to create CATA questionnaire. One of these methods is that participants generate words and terms in focus group discussions. An advantage of using focus group discussions' finding is that consumers can generate descriptors during the discussion like in free choice profiling. Hence, participants are allowed to use as many individual words as they want, to characterize the product and, subsequently, to identify the attributes intensity to get precise evaluations of consumers. In fact, focus group panels can create descriptors which are understandable for other consumers. However, in general, it may be difficult for consumers to find the right words in order to describe their perception (Deliza et al. 2005, González Viñas et al. 2001, Gonzáles-Tomás et al. 2006).

1.2.6. Just-about-right (JAR)

According to Lawless and Heymann (2010), JAR is a bipolar scale which can be used in consumer testing. Furthermore, it can be used in acceptance or preference testing as well as in product development and product re-formulation. It can be a useful technique for determination of optimum ingredient levels (López Osornio et al., 2010). In case of product development, the scale gives immediate formulation directions but no absolute intensity information can be obtained. Lawless and Heymann (2010) mention JAR as a method for measuring consumer´s reactions to specific attributes.

JAR scales have three or five categories for each attribute which are anchored with opposite end anchors (too little, too much) and a middle point anchored as just about right. One major advantage is that two kinds of information can be obtained from the scale at once: hedonic judgements and attribute's intensity (Lawless and Heymann, 2010). The bias of panellists should be taken into consideration. Therefore, the scale

needs to be adjusted to avoid overshoot (too much) or undershoot (too weak) of optimal intensity. Furthermore, Gacula et al. (2007) showed that JAR questions can determine products' acceptance or liking. On contrary, instead of acceptance, JAR can be seen as a reference point of intensity's descriptors (McBride, 1985).

2. MATERIALS AND METHODS

2.1. Research materials

Six sweetpotato varieties were used in the first study (Table 1) and ten potato varieties were used in the second (Table 2).

Samples from each variety were boiled following the same process, that is cut in slices of 50 g, put in a food plastic box and cover in order to retain the odor. Before tasting, the samples were served on paper dishes, and randomly assigned three-digit codes (Figure 1). All samples were stored and served at room temperature. All experiments were carried out at the Sensory Laboratory, Hanoi University of Science and Technology (HUST) with 12 standardized booths and an equipped kitchen (Figure 2).

Table 1. Studied varieties of sweetpotatoes

No.	Name of variety	Photos	Location of collection	Likely origin	Price VND/kg
1	Red Hoang Long		Farmer field in Ba Vi district	Ba Vi	12,000
2	White Hoang Long		Roadside retailer in Ba Vi district	Ba Vi	14,000

3	Beniazuma (Japanese variety)		Roadside retailer on AH13 road (Hoa Binh)	Son La	16,000
4	Khoai Mat		Market retailer in Ha Noi	Dak Lak	25,000
5	Khoai Bo		Market retailer in Ha Noi	Dak Lak	25,000
6	Imported from China		Market retailer in Ha Noi	China	40,000

Table 2. Studied varieties of sweetpotatoes

Sample code	Name of variety	Location of collection	Likely origin	Price VND/kg
Sample No.1	O7 (Utatlan)	Supermarket in Da Lat	Da Lat	23,000 (460,000)
Sample No.2	PO3 (Igorota)	Farmer field in Da Lat province	Da Lat	18,000 (360,000)
Sample No.3	Atlantic	Farmer Hai Phong	Hai Phong	7,500 (150,000)
Sample No.10	KT1	RCRDC	Ha Noi	18,000 (360,000)

Sample code	Name of variety	Location of collection	Likely origin	Price VND/kg
Sample KT1	KT4	RCRDC	Ha Noi	18,000 (360,000)
Sample KT4	KT5	RCRDC	Ha Noi	18,000 (360,000)
Sample KT5	KT6	RCRDC	Ha Noi	18,000 (360,000)
Sample KT6	Solara	RCRDC	Ha Noi	18,000 (360,000)
Sample Marabell	Marabel	RCRDC	Ha Noi	18,000 (360,000)
Sample Solara	Markies	Fresh Studio	Moc Chau	-

Figure 1. Example of served samples

Figure 2. HUST Sensory Laboratory

2.2. Quantitative Descriptive Analysis

2.2.1. QDA panelists

The QDA panel was composed of 10 trained panellists (two men and eight women) who were HUST staff aged from 28 years to 53 years.

2.2.2. Procedure

Panellists were trained and asked to carry out the descriptive test in accordance with ISO 11035:1994, as shown in Figure 3.
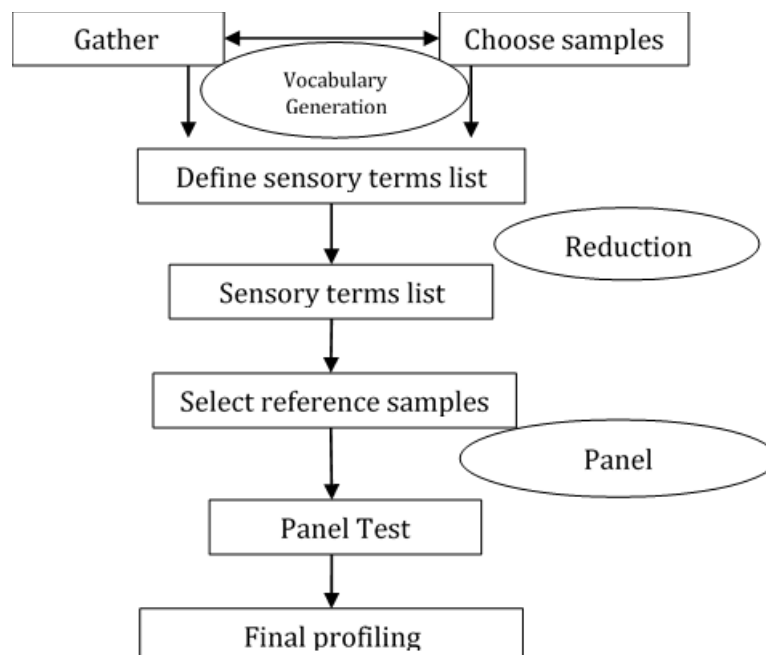
Figure 3. The flowchart of Quantitative Descriptive test

- *Generation of attributes*

A generation of attributes was conducted by a repertory grid method. Panellists were presented with three triads of samples. For each triad, panellists were asked to look for the product that they considered the most different in terms of sensory properties and to describe how this product was different from the two others. Then, they were asked to indicate how the two other products were similar. Generated terms were compiled to form a preliminary list. Whenever the meaning of one term was not clear within the panel, the panellist who had used it was asked to explain. Panellists were free to add attributes to the list if necessary. During the next sessions, panellists were asked to rate every attribute on a 6-point intensity scale (from 0 = no perception, 1 = weak perception, 5 = strong perception) for all samples. A reduction of the list of attributes was then performed following the ISO11035 (1994) norm.

- *Panel training*

During six 2-hours-training sessions for sweetpotato samples and five similar training sessions for potato samples, panellists discussed and agreed upon definitions, references and evaluation procedures for each attribute and they were trained to rate the intensity of all attributes on 10 cm scale. Panel proficiency was checked at the end of the training ensuring the agreement among panellists, repeatability of each panellist and the discriminative power of the panel.

- *Final profiling*

In the final profiling, all varieties were evaluated in duplicate. During the final evaluation, samples were presented to panellists following Latin Square orders, and they received sample by sample.

2.2.3. Data analysis

The obtained results were processed by Principal Component Analysis (PCA) with the XLSTAT software.

2.3. Focus group Discussions

2.3.1. Focus group panel

Sixty-four (64) people were recruited according to established criteria to participate in the study on sweetpotato. Another group of sixty-four people were recruited in the

potatoes study. The focus group discussion was conducted on 8 groups of consumers with the following characteristics (Table 3).

Table 3. Characteristics of Focus group participants

Groups	Gender	Age	Family Income (VND/month)
1.	Male	< 25 years old	> 20,000,000
2.	Male	< 25 years old	≤ 20,000,000
3.	Male	25 - 45 years old	> 20,000,000
4.	Male	25 - 45 years old	≤ 20,000,000
5.	Female	< 25 years old	> 20,000,000
6.	Female	< 25 years old	≤ 20,000,000
7.	Female	25 - 45 years old	> 20,000,000
8.	Female	25 - 45 years old	≤ 20,000,000

In 2020, the average income in Hanoi was around 10 million/persons/month (General Statistics Office, 2020). Therefore, a family with an income > 20,000,000 VND/month was considered as a high-income family, and a family with an income ≤ 20,000,000 VND/month was considered as a low- or medium-income family. Participants who were less than 25 years old represented young groups, and participants who were between 25 and 45 years old represented middle-age groups.

After contacting the participants and arranging the most suitable time, focus group discussions were held at the sensory analysis laboratory or at the participants' residences.

The study was performed in agreement with the ethical guidelines for scientific research of HUST. The participants were informed about the discussion procedure and were also asked to give written informed consent before the test. All personal information was protected and served only for the research purpose. After the discussion, participants received a thank you gift.

2.3.2. Procedure

Each discussion on the research topic (sweetpotatoes/potatoes) lasted from 40 to 60 minutes. During the discussions, participants were first asked about everything that came into their mind regarding the terms "sweetpotatoes/potatoes" in general. There were no

restrictions but free expression of opinions. To make the participants comfortable, the focus group was conducted in their native language and they were invited to introduce themselves in a short way at the beginning of the talk (ice breaker). After introducing the panellists, the moderator welcomed the participants and opened the discussion by introducing the topic. To get as much personal attitudes, opinions and sharing as possible, the panellists were encouraged to express themselves by mentioning that there would not be right or wrong answers. Also, that other opinions and freedom of participation would be respected. If the discussion got stuck or wandered from the given subject, the moderator led the focus back to the focal theme or encouraged participants that did not contribute much to share their perspectives as well. After a while, some boiled samples were served to the members in order to test them. The discussion was recorded by voice recording as well as with written notes by a note-taker. They were consistent throughout the focus group discussions because of a discussion guideline (Annex 1). Descriptors that were mentioned in the focus groups were extracted and used for the CATA questions.

2.3.3. Data analysis

All voice recordings were listened to by two researchers (the moderator and the note-taker) in order to look for all opinions, themes, statements and ideas given from participants in the focus group discussions.

2.4. Consumer Test

2.4.1. Consumer panel

Eighty participants were recruited from HUST network and database, with detailed information as shown in table 4, figure 4 and table 5, figure 5.

Table 4. Participants in the consumer test of Sweetpotatoes

Gender	18-23 years old	24-30 years old	31-40 years old	> 40 years old	Total
Male	8	7	11	9	35
Female	13	9	11	12	45
Total	21	16	22	21	80

Family income

Age

7.5-15m
27%

<3m
50%

4.5-7.5m
5%

3-4.5m
6%

15-30m
10%

>30m
2%

>40
26%

18-23
26%

31-40
20%

24-30
28%

Gender

Male
44%

Female
56%

Married
and has not
children
yet
5%

Other
1%

Marital status

Married
and has
children
39%

Single
55%

Profession

Engineer
4%

Expert
2%

Office staff
14%

Student
25%

Freelancer
10%

Worker
13%

Goverment Staff
13%

Teacher
19%
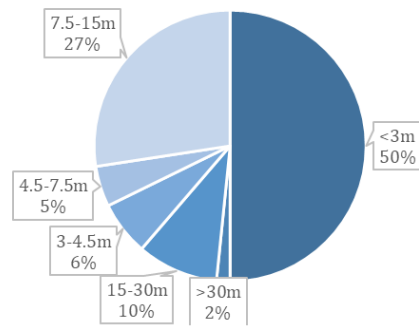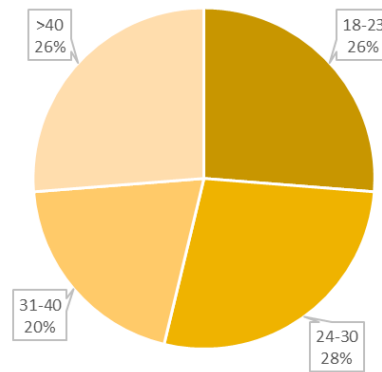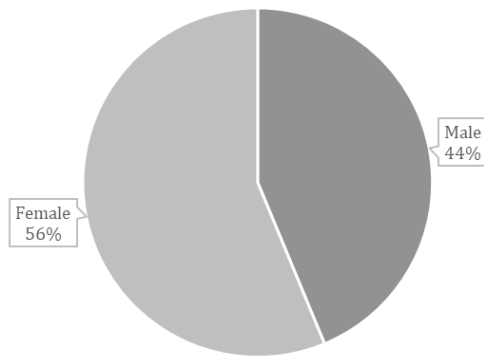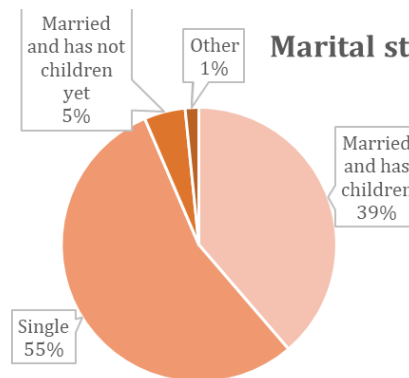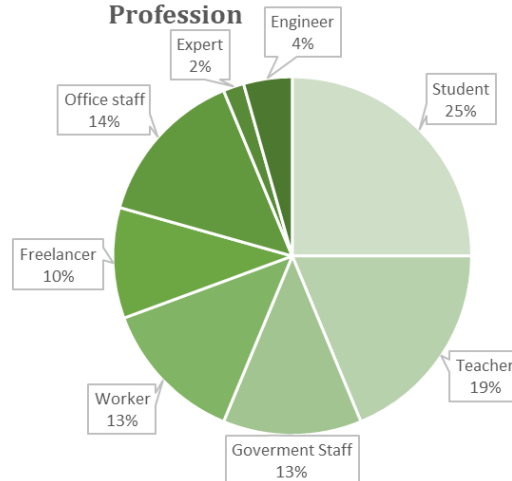
Figure 4. Some demographic information of participants in the consumer test of sweetpotatoes

Table 5. Participants in the consumer test of potatoes

	18-24 years old	24-30 years old	30-40 years old	Above 40 years old	Total
Male	11	9	10	12	42
Female	11	11	7	9	38
Total	22	20	17	21	80
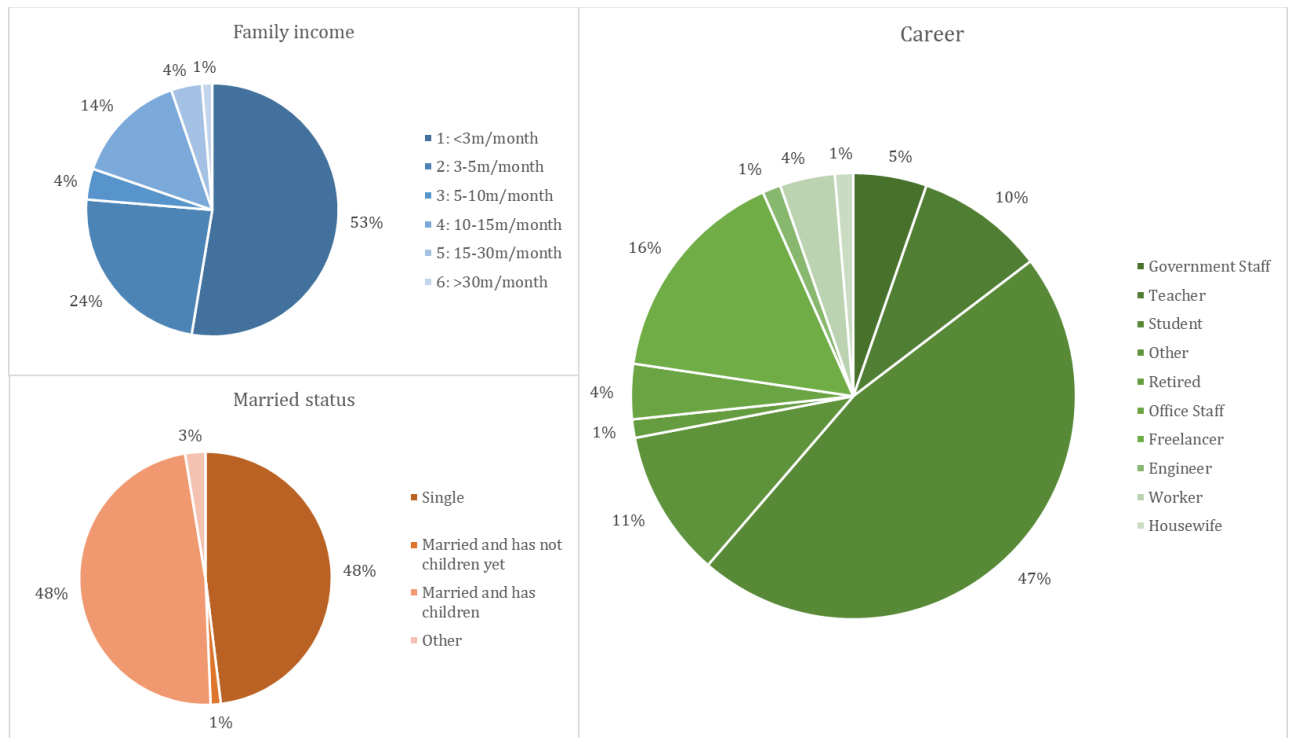
Figure 5. Some demographic information of participants in the consumer test of potatoes

2.4.2. Procedure

Participants were invited to the HUST Sensory laboratory to carry out the test. A questionnaire was prepared and two moderators instructed participants to answer it (*Annex 2*). After the test, participants were given a thank you gift.

- *Hedonic test*

Samples were coded and presented one by one according to a Williams Latin Square method. No information about the tested products was communicated to panellists before and during the test. Panellists were asked to score their overall liking on **7-point scales** anchored from "I dislike very much" (1) to "I like very much" (7). Hence, samples with liking score above 4 were considered to be accepted by consumers. In addition to

overall liking for the test sample, the consumers were also be asked about their preference for each group of attributes such as odor, taste, texture and aftertaste. Mineral water was used to rinse the mouth between samples.

- *Check-All-That-Apply test (CATA)*

Terms extracted from Focus groups discussions were used in the CATA test. Consumers were asked to check the terms they found most appropriate to describe the products. From this information it was possible to elicit the respondent's perception of each sample, in order to explain its acceptability level.

- *Just-About-Right test (JAR)*

Consumers were invited to test the products and rate the intensity of each attribute on a 3-point JAR scale with a central score of "just about right" (Too Little/Just about right/Too much). Hence, it was possible to determine the attributes that needed to be adjusted as well as the direction of adjustment (increase or decrease) to maximize consumers' satisfaction.

2.4.3. Data analysis

- *Hedonic test*

The hedonic scores from the consumer panels were subjected to a two-way ANOVA with the following model, with "panellists" as random factor.

$$Score = panellists + product + product \times panellists + error$$

When significant effects occurred, a mean comparison LSD test was performed.

Otherwise, the results of preferences were also processed by HAC - Hierarchical Ascendant Classification algorithm to classify the consumers according to their liking scores and to understand more about consumer clusters that have similar preferences.

- *CATA test*

The CA (Correspondence Analysis) algorithm was used to analyse the matrix of usage frequency of each term to locate and describe the group of six varieties.

- *JAR test*

The Penalty Analysis algorithm was used to identify attributes that need improvement and suggest directions for improvement.

3. RESULTS

3.1. Part A – Results of research on Sweetpotato

3.1.1. Quantitative Descriptive Analysis

List of attributes

The panel generated 30 attributes. After a reduction following ISO 11035:1994, a list of 22 attributes were used for the QDA test (Table 6 and 7).

Table 6. Reduction of descriptors in Sweetpotatoes QDA test.

STT	Descriptors	F	Pr > F	Conclusion
1	[IN] Yellow-as-turmeric	27.430	< 0.0001	Keep
2	[IN] Green yellow	17.528	< 0.0001	Keep
3	[IN] Yellow-as-bean	26.521	< 0.0001	Keep
4	[IN] Homogeneous	6.586	0.000	Keep
5	[IN] Smooth	5.696	0.000	Keep
6	[Peel] Yellow	17.481	< 0.0001	Keep
7	[Peel] Brown	0.101	0.991	
8	[Peel] Red	10.208	< 0.0001	Keep
9	[SF] Wet	9.160	< 0.0001	Keep
10	[On hand] Dry	9.900	< 0.0001	Keep
11	[On hand] Soft	12.867	< 0.0001	Keep
12	[On hand] Sticky	8.503	< 0.0001	Keep
13	[On hand] Smooth	6.751	0.000	Keep
14	[On hand] Wet-pasty	21.867	< 0.0001	Keep
15	[Odor] Potato	0.442	0.816	
16	[Odor] Honey	10.238	< 0.0001	Keep
17	[Odor] Starch	8.547	< 0.0001	Keep
18	[Odor] Rotten	1.203	0.325	
19	[Taste] Sweet	10.250	< 0.0001	Keep
20	[Taste] Sour	0.498	0.776	
21	[Flavor] Potato	0.031	0.999	
22	[Flavor] Starch	12.367	< 0.0001	Keep
23	[Aftertaste] Sour	0.397	0.848	
24	[In-mouth] Slippery	3.972	0.005	Keep
25	[In-mouth] Smooth	2.497	0.046	Keep
26	[In-mouth] Soluble	3.110	0.018	Keep
27	[In-mouth] Fiber	0.141	0.981	
28	[In-mouth] Teeth-sticky	1.999	0.100	
29	[In-mouth] Mealy	17.240	< 0.0001	Keep
30	[In-mouth] Throat-tightness	4.840	0.001	Keep
Highlighted rows: not keep descriptors				

Table 7. Definition of 22 final descriptors in sweetpotatoes

	Groups	Descriptors	Definition
1	[IN] Inside	[IN] Yellow-as-turmeric	Samples are cut in slices to observe the flesh of samples. Observe carefully the surface of slice and evaluate its colors. Yellow has different shades.
2		[IN] Green yellow	
3		[IN] Yellow-as-bean	- Yellow-as-tumeric is similar with the color of tumeric - Green yellow means that green exists on studied slice. - Yellow-as-bean is similar with the color of green-bean
4		[IN] Homogeneous	
5		[IN] Smooth	
6	[Peel] Peel	[Peel] Yellow	
7		[Peel] Red	
8	[SF] Surface of the slice	[SF] Wet	
9	[On hand] Texture on hand	[On hand] Dry	Using fingers press gently the sweetpotato on the surface, feel the water content of sample. The less water in sweetpotato, the drier sample is, and reversely.
10		[On hand] Soft	Using index finger to press sweetpotato with the same force. The easier sweetpotato sink, the softer sweetpotato is and reversely.
11		[On hand] Sticky	Sweetpotato is placed between two fingers, lift it up and down to feel sticky between fingers. The easier fingers lift it off, the stickier it is and reversely.
12		[On hand] Smooth	
13		[On hand] Wet-pasty	
14	[O] Odor	[O] Honey	Breaking a sweetpotato or mashing it by two fingers and smell it. Assessing the intensity of each odor. Very strong odour intensity will be felt strong, and note with high scores
15		[O] Sweetpotato	
16	[F] Flavor	[F] Sweetpotato	The specific flavour of sweetpotato, which help us to disctint sweetpotato with others roots.
17	[T] Taste	[T] Sweet	
18	[In-mouth] Texture in mouth	[In-mouth] Slippery/liquide	
19		[In-mouth] Smooth	
20		[In-mouth] Soluble	Using tongue to press the SP into the roof of mouth, estimate the time SP dissolve on tongue. The quicker it dissolves, the more soluble and vice versa,
21		[In-mouth] Mealy	Using hands to break sweetpotato into 2 pieces and observe the surface: starchy, loose and less water. Eating a piece of sweetpotato and using tongue to feel the fragmentation and dryness of sample. The faster sweetpotato fragile, the looser it is, the less water it gets, the more it is mealy.
22		[In-mouth] Throat-tightness	

Note: There are some descriptors that are easy to be understood by panel, so we have not their definitions.

After the generation of final descriptor list, the panel discussed together to find out the definition of descriptors. Then, they were asked to evaluate the intensity of each descriptors on a scale from 0 to 10 (0 = no found that characteristique, 1 = very weak intensity, 10 = very strong intensity).

Product positioning and sensory map

PCAs performed on the product x panelist matrix showed a good consensus among panelists for every descriptor. This indicates that the interactions reflected differences in the magnitude of the scores between panelists, rather than ranking differences.

Principal Component Analysis:

Eigenvalues:

	F1	F2	F3	F4	F5
Eigenvalue	13.696	5.890	1.558	0.688	0.168
Variability (%)	62.253	26.774	7.081	3.129	0.762
Cumulative %	62.253	89.028	96.108	99.238	100.000
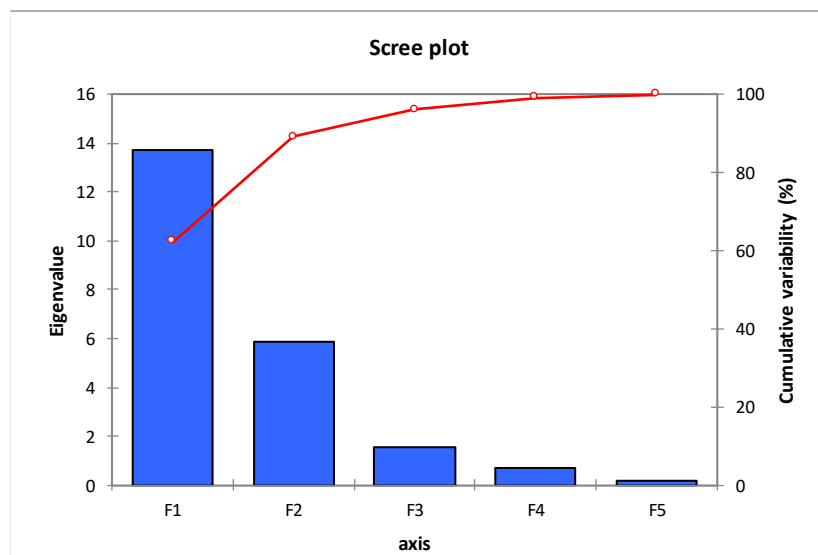
Figure 6. Information about the most informative dimensions of product space

With 22 data dimensions (corresponding to 22 attributes), the Principal Component Analysis (PCA) was performed to simplify and find the main axis representing maximum information about products' space. The cumulative variability of the main axis can be found in figure 6.

Among these main axes, F1 and F2 were the two axis that showed the most information of the product space (80.87% of the amount of information). With two axis F1 and F2, attributes were shown on the correlation circle (Figure 7).
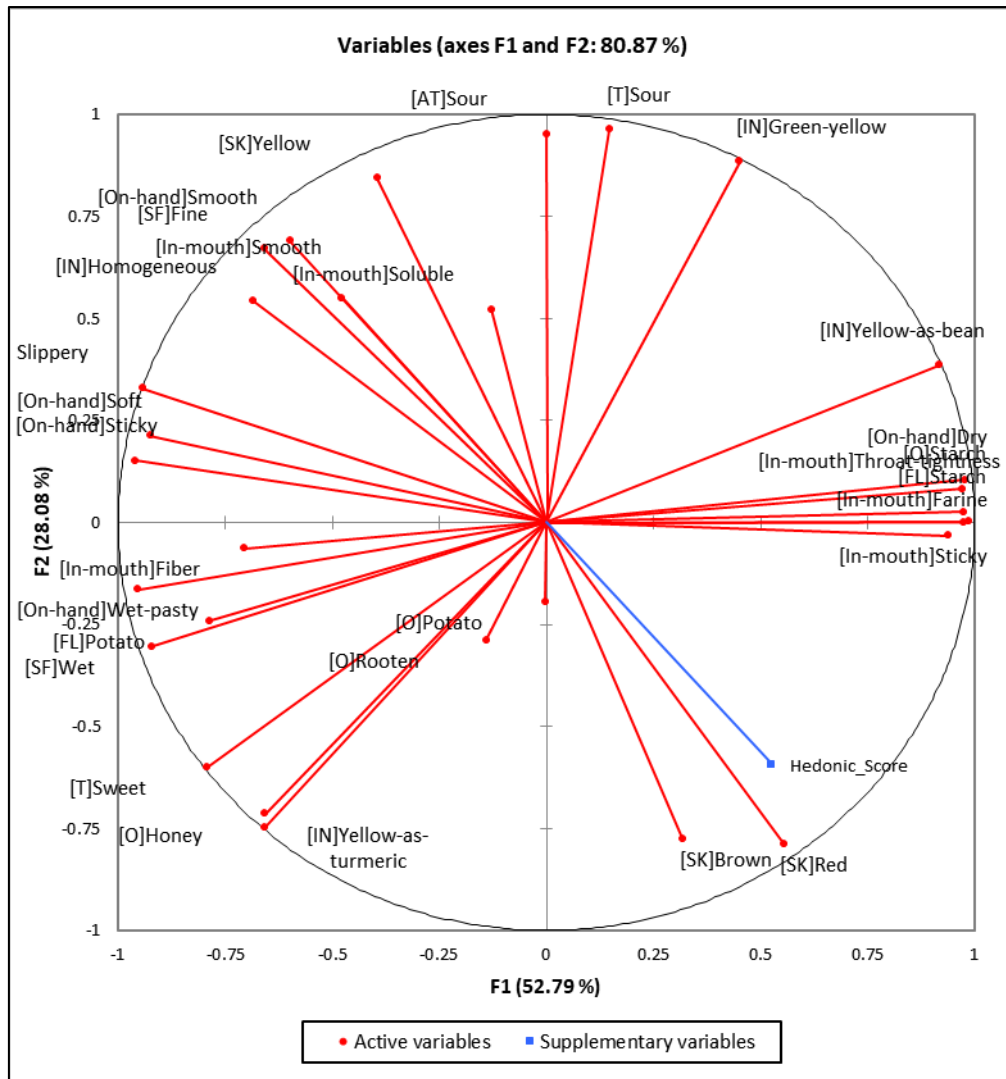
Figure 7. The correlation circle of attributes with overall-liking score as additional variable

(*IN=inside, SK = peel, SF = surface, O = odor & aroma, T = taste, AT = after taste, On-hand = texture on hand, In-mouth = texture in mouth*)

Attributes well represented through the axe F1, F2 were near the circle. Attributes with positive correlation were grouped together. Uncorrelated attributes were orthogonal to each other. Attributes with negative correlation were plotted on opposing quadrants of that plot.

Combined with the observation of Correlation matrix (table of Pearson correlation coefficients between pairs of variables) and Table squared cosines, we had the following observations:

- Almost all attributes were well represented on the plane (F1, F2), except [In-mouth] Soluble: well represented on (F2, F3).
- [Inside] Yellow-as-bean, [On hand] Dry, [Odor] Starch, [Flavor] Starch, [In-mouth] Mealy, [In-mouth] Throat-tightness had high positive correlation

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(Coefficient Pearson correlation > 0.88). Those attributes were negatively correlated with [On hand] Soft, [On hand] Sticky and [In-mouth] Slippery.

- [Inside] Green yellow was negatively correlated with [Inside] Yellow-as-turmeric, [Odor] Honey, [Taste] Sweet.
- [IN] Yellow-as-bean was negatively correlated with: [IN] Yellow-as-turmeric, [Surface] Wet, [On hand] Wet-pasty, [Taste] Sweet and [On hand] Sticky.
- [Peel] Red was negatively correlated with: [IN] Homogeneous, [IN] Smooth, [On hand] Smooth, [In-mouth] Smooth.

Table 8. Table Cos² of attributes

	F1	F2	F3	F4	F5
[IN] Yellow-as-turmeric	0.415	**0.563**	0.000	0.022	0.000
[IN] Green yellow	0.190	**0.770**	0.011	0.023	0.005
[IN] Yellow-as-bean	**0.827**	0.151	0.004	0.016	0.002
[Peel] Yellow	0.162	**0.764**	0.001	0.069	0.004
[Peel] Red	0.325	**0.583**	0.089	0.002	0.001
[Surface] Wet	**0.843**	0.116	0.011	0.017	0.013
[IN] Homogeneous	**0.487**	0.262	0.211	0.034	0.005
[IN] Smooth	**0.454**	0.403	0.141	0.001	0.000
[On hand] Dry	**0.952**	0.019	0.000	0.018	0.011
[On hand] Soft	**0.861**	0.036	0.033	0.057	0.013
[On hand] Sticky	**0.924**	0.018	0.020	0.011	0.027
[On hand] Smooth	0.368	**0.451**	0.052	0.123	0.006
[On hand] Wet-pasty	**0.908**	0.042	0.000	0.043	0.006
[Odor] Honey	0.410	**0.476**	0.085	0.025	0.004
[Odor] Starch	**0.942**	0.012	0.012	0.034	0.000
[Taste] Sweet	**0.615**	0.378	0.000	0.003	0.004
[Flavor] Starch	**0.950**	0.001	0.011	0.026	0.011
[In-mouth] Slippery	**0.898**	0.096	0.001	0.004	0.001
[In-mouth] Smooth	0.224	**0.389**	0.233	0.142	0.011
[In-mouth] Soluble	0.016	0.358	**0.618**	0.001	0.007
[In-mouth] Mealy	**0.977**	0.000	0.015	0.008	0.000
[In-mouth] Throat-tightness	**0.946**	0.000	0.008	0.009	0.036

Finally, the varieties (observation) were represented on the map (F1, F2) as shown in the next figure. Varieties with larger rings were better represented by the plane (thus, product "No5 Khoai Bo" did not fit this plane yet). The closer a product was to any major axis, the better it was to be represented by that axis.
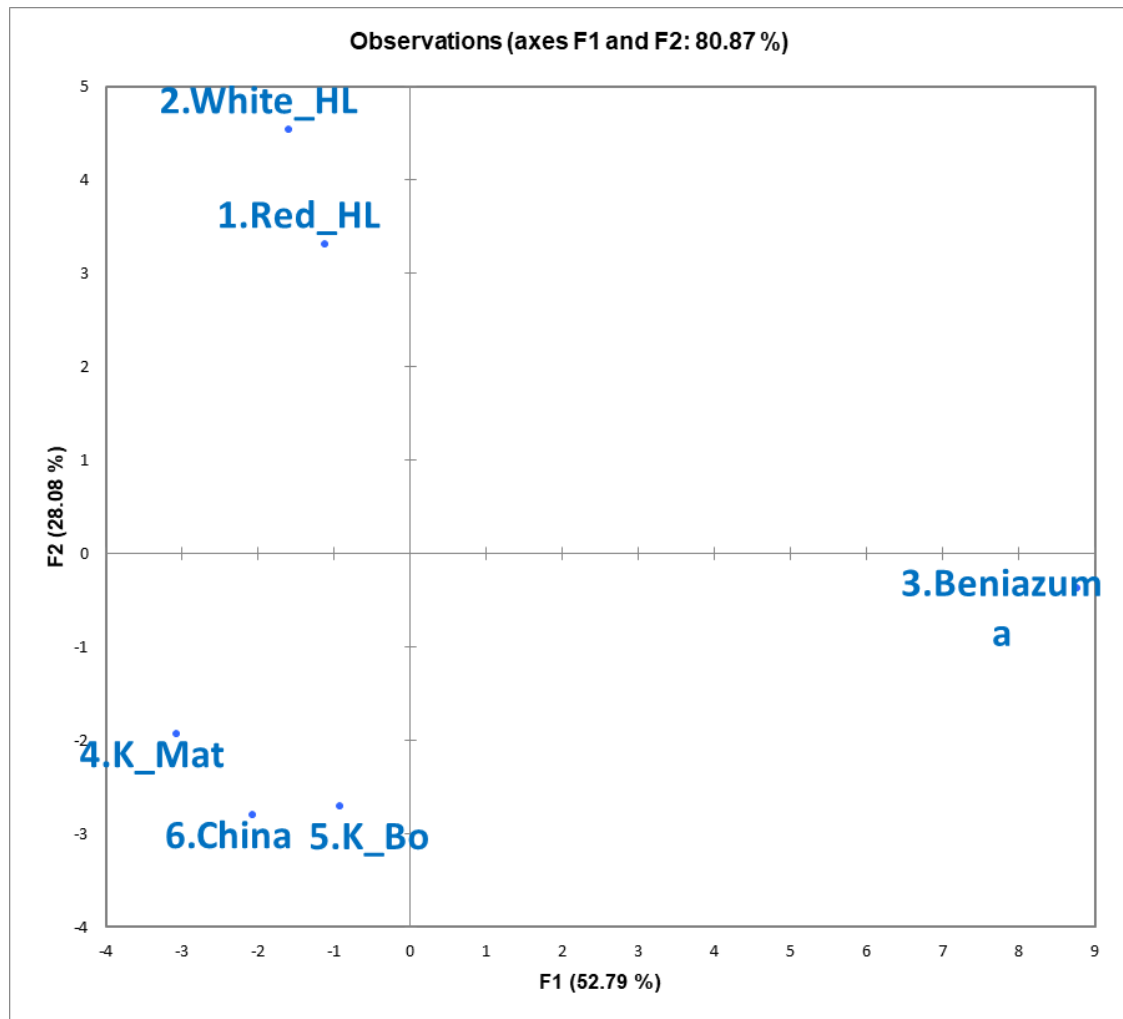
Figure 8. Product space map with correlation circle of attributes (a)

Figure 9. Product space map with correlation circle of attributes (b)

Based on that map, combined with the above correlation circle, we divided varieties into 4 separate groups (Table 9)

Table 9. Characteristics of sweetpotato products

Group	Product	Characteristics
1	Beniazuma	[IN] Yellow-as-bean, [On hand] Dry, [Odor] Starch, [Flavor] Starch, [In-mouth] Throat-tightness, [In-mouth] Mealy.
		Low strength attributes: [On hand] Sticky, [On hand] Soft, [SF] Wet, [In-mouth] Smooth, [IN] Homogeneous, [IN] Smooth, [Taste] Sweet

Group	Product	Characteristics
2	Red_Hoang Long White_Hoang Long	[Peel] Yellow, [IN] Green yellow, [On hand] Smooth, [In-mouth] Smooth, [IN] Homogeneous Medium strength attributes: [Taste] Sweet
3	Khoai Mat China imported	[IN] Yellow-as-turmeric, [On hand] Sticky, [On hand] Soft, [On hand] Wet-pasty, [SF] Wet, [Odor] Honey, [Taste] Sweet Low strength attributes: [On hand] Smooth, [In-mouth] Throat-tightness, [In-mouth] Mealy.
4	Khoai Bo	[IN] Yellow-as-turmeric, [Odor] Honey, [Peel] Red Low strength attributes: [In-mouth] Soluble

Product profiles

Figure 10. Profile of all 6 sweetpotato samples

Figure 10 showed the characteristics of all 6 sweetpotato samples and we can observe the differences between samples.

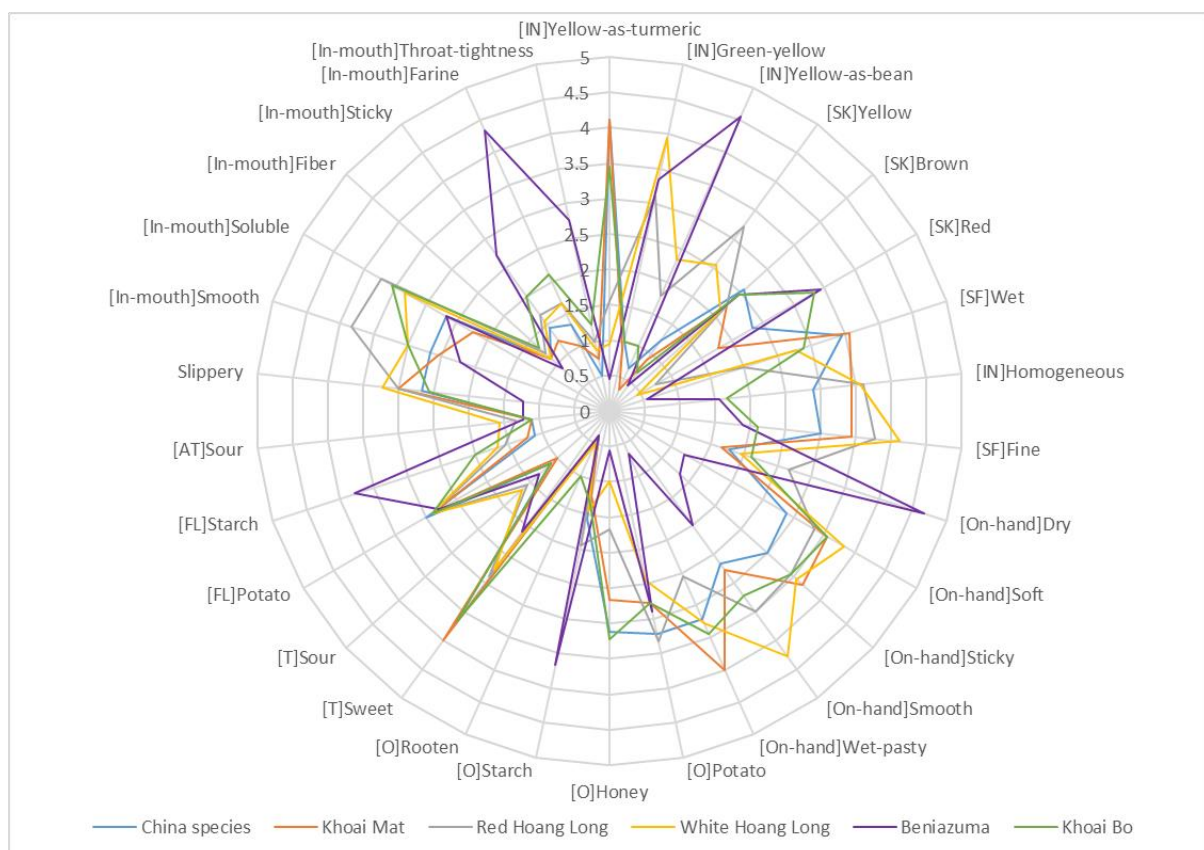### 3.1.2. Focus group Discussion

Table 10 contain some statement and most chosen options of each statement about consumption habits of consumers on the sweetpotato. Most of consumers usually *boil/steam sweetpotato* and variety that they choose is *purple sweetpotato (Japanese variety)*. In most of consumer's opinion, favourite shape is *oblong* and favourite colour is *yellow*. Besides, sweetpotato was used to consume as side dishes instead of main dishes.

Table 10. Statement and most chosen opinion of consumption habit questionnaire

Statement	Most chosen opinion	Quantity of consumer choose opinion
Used sweetpotato varieties	Purple sweetpotato (Japanese and domestic variety)	30/106
Type of cooking	Boil/steam	98/106
Sweetpotato selection factors	Quality	87/106
Varieties for boiling	Purple sweetpotato (Japanese variety)	80/106
Varieties not for boiling	No variety not for boiling	39/106
Favourite shape of sweetpotato	Oblong	62/106
Favourite sweetpotato peel 's characteristics	No black dot	79/106
Favourite sweetpotato flesh colour	Yellow	83/106
Characteristics of high quality sweetpotato	Characteristic flavour Sweet	87/106 86/106
Sweetpotato consuming time	Eating when being hungry Side dishes	66/106 64/106
Reason for choosing sweetpotato to replace other foods	Good price	57/106
Acceptable price of sweetpotato	15.000 – 20.000 VND/kg	45/106
Minimum acceptable price	5.000 VND/kg	49/106
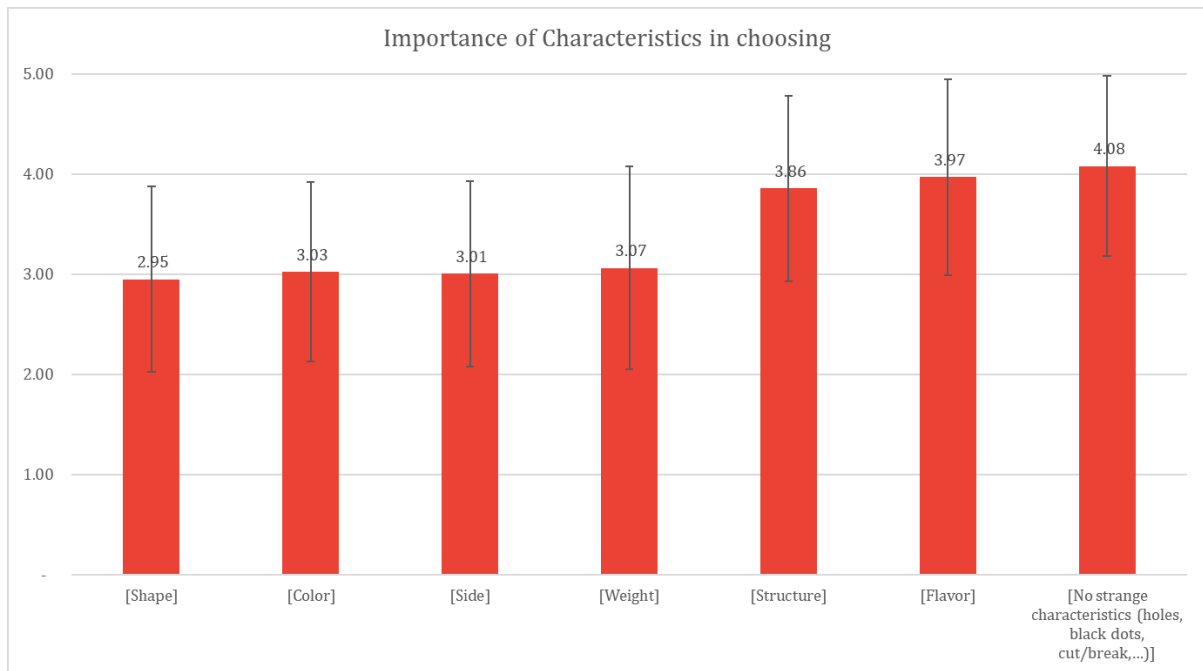
Figure 11. The importance level of sweetpotato's characteristics in consumers' choice

The most important characteristic that is paid attention when consumer choose sweetpotato is the appearance of strange things (holes, black dots, cut/break ...) with average important level is 4.08 (standard error 0.81). In addition, majority of consumers usually eat sweetpotato at least 1 time per week.
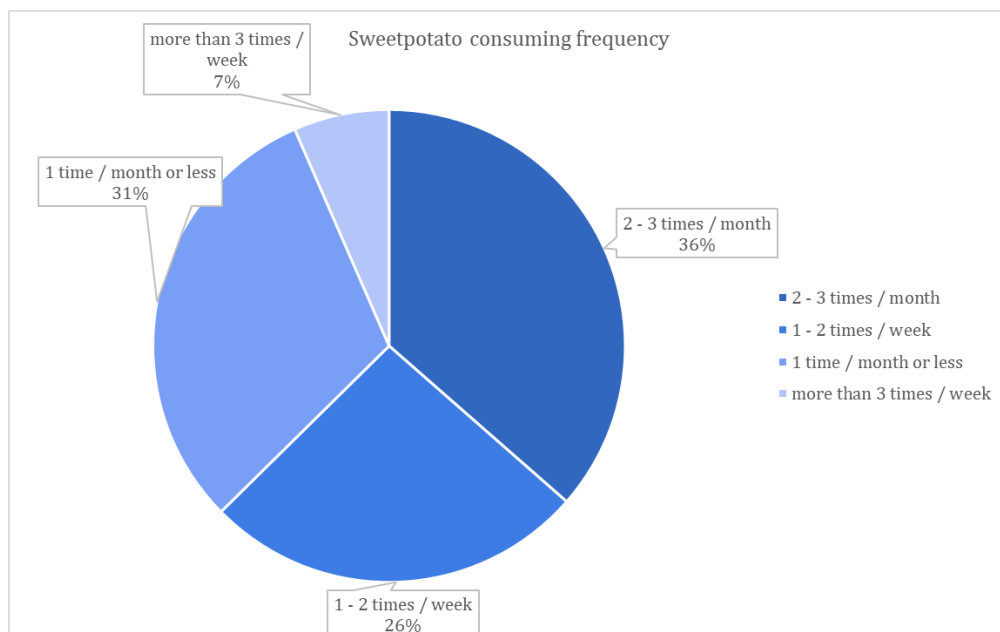

Figure 12. Sweetpotato consuming frequency

Consumer's general perception about sweetpotatoes

Table 11. Summary of Consumer's general perception about sweetpotatoes

	Sweetpotatoes (SP)
Social representation	- Very good for health: helping body weight control, good for digestion, - Feel comfortable and light when consume SP - Tasty vs. Easy to make full
Usage and Attitude	- Not a everyday food, eat when available and when think about it - Eat at noon to skip lunch - Boiled or grilled SP, SP can be easily cooked by microwave oven - A snack food or a side-dish - Not easy to keep SP for long time - Toxic when sprouting - Children do not like SP
Product and Market experience	- Not cheap, 1 kg of SP is equal to 2kg of Rice - Japanese variety is expensive, 20,000k/kg - Mealy vs. Puree - Honey sweet vs. Tasteless - Yellow vs. Pale
Compairison between SP and potato (P)	- P is cheaper and easier to eat than SP - SP is a finger/snack food, not a dish of a meal like P

Between different income and age groups, there was not much difference observed. However, a major difference was observed between the women and men's group. Women groups shared a lot of information about SP and P, whereas men's groups seem to be just "eaters".

- *Social representation of sweetpotatoes*

All participants in the Focus group discussions described their own image of sweetpotatoes in detail. Their common feature was related to grilled sweetpotatoes, and everyone had the impression that sweetpotato was a healthy food. One participant said: *"I remember the most when it comes to sweetpotatoes when returning home to gather sweetpotatoes and grilled them for the first time."*

For the male group, they were impressed that sweetpotato was a rustic dish. For the female group, sweetpotato was a dish that everyone could eat, both children and adults can eat it and it is safe for health. In particular, sweetpotatoes was delicious because of its good smell, sweetness and mealiness.

Table 12. Preferred sweetpotato varieties by gender groups

Purpose	Male group	Reason	Female group	Reason
Boiled	Purple sweetpotato (flesh and peel) Orange sweetpotato Sweetpotatoes with purple peel, yellow flesh White potatoes	Delicious, sweet, mealy	Da Lat sweetpotato: 2 types of yellow and purple flesh Japanese sweetpotato: yellow (mealy and sweet) White potatoes: purple peel, white flesh, taste ike Japanese sweetpotatoes but different color	Delicious, fun, snack Mealy, slightly dry
Grilled	Khoai Mat	Sweet, soft	Khoai Mat	

A male participant said: *Usually, I buy purple type of sweetpotato. Other types of sweetpotatoes are also available, but people rarely eat it, people usually buy this type of sweetpotato to eat* (Japanese sweetpotato with yellow flesh, purple peel)

One woman added about her preference for white sweetpotatoes with the comment: *"It's a bit dry, mealy, it's choking, but I still like it better..."*.

Table 13. Least preferred sweetpotato varieties by gender groups

Purpose	Male group	Reason	Female group	Reason
Boiled	Khoai Mat	Bland	Purple sweetpotato	Taste not good, even though it's sweet Eat a bit salty, taste brackish
			Khoai Mat	Blander than when baked A bit fragile

9/13 participants had never bought fresh Khoai Mat or eaten boiled Khoai Mat.

Table 14. Gender-differentiated preferred characteristics when buying fresh sweetpotatoes

Characteristics	Reason	
	Male	Female
Size / shape	Big and long / Round shape Not too big, but long enough. The size fits the mouth when biting Middle part of sweetpotatoes is moderately big Long shape, elongated, generally not too small Not too big, big sweetpotatoes are more suitable for frying	Medium, not too big Long
Surface characteristics	Smooth peel Not black Looks fresh, clear color	Smooth Dark purple color, the color should not be too light because the taste will be bland Entire surface of the sweetpotato is uniform in color No black spots Yellow, not white, sweetpotatoes with white peel will be bland The peel is light, pale in color, avoid dark colors because when boiled, it smells like alcohol
Texture	Hard when touching, not soft, soft means it has been stored for a long time, spoiled	

Table 15. Gender-differentiated least preferred characteristics when buying fresh sweetpotatoes

	Male		Female	
	Characteristics	**Reason**	**Characteristics**	**Reason**
Size	Too big The size is not suitable for the intended use	Can still be boiled, but it takes a lot of time Unevenly cooked	Too big Too short	Hard to be boiled Hard to be cooked
Shape	Folded shape		Humpback shape	Difficult to eat, difficult to steam, fibrous
Taste	Bland	Not good		
Surface	Has bugs, weevil, rough Looks suspicious, spotty Strange signs	After boiling, the sweetpotatoes are hard and not good to eat Damaged, signs of pests, weevils	Holes, signs of pests, weevil	Bitter taste, characteristic smell of sweetpotatoes damaged by pests, weevils
Other	Damaged, bruised peel Soft, rotten The type/variety of sweetpotatoes you do not want to use Cuts, breaks	Stale Like to eat Japanese sweetpotato instead of Khoai Mat, due to eating habits, Khoai Mat is less popular	Bruises Strange color compared to usual Old sweetpotatoes (the respondents did not know the specific characteristics, but chose through feelings and experiences)	Too fibrous

Table 16. Most preferred characteristics when choosing fresh sweetpotatoes by gender groups

The male group's opinions	The female group's opinions
- Hard, no signs of pests, the size is suitable for use - No holes, hard, size - Color, size, no spots	- Oblong shape, uniform color, no black spots - Color, size, no black spots - Not bruised

- Clear bright colors, smooth peel, heavy - Size, fresh color, type of sweetpotato - No weevil ⇨ No pests, bright color, size.	- No holes, uniform size, bright color - Variety, price, size (even in size) ⇨ No black spots, bright color, size.

Two women said that when they buy sweetpotatoes, they often choose tubers with the same size to boil them in the same process (temperature, amount of water, etc). Otherwise, if sweetpotatoes have different sizes, when she boiled them, she had to take out small tubers first and then continue to boil the big ones during longer time.

In general, men were less interested in the price (did not pay attention to the price and only knew the price of the most popular mid-range) and the frequency of buying was very little (2-3 times/year, 1-2 tubers/time).

Interestingly, women with low income paid attention to sweetpotatoes with higher prices (20,000-40,000 VND/kg) while women with high income paid attention to sweetpotatoes with lower price (7,000-20,000 VND/kg). In particular, female students had a defensive mentality towards cheap sweetpotatoes.

With regard to the selection criteria for sweetpotatoes, males preferred large sweetpotatoes and believed in the seller's choice while females had very specific and detailed criteria. However, between the group of high-income women and low-income women, there were different ways of thinking when choosing sweetpotatoes:

- High-income women paid more attention to the defects (do not choose withered, dark-peel, had shoots, wrinkled peel, many eyes/holes, had soil on peel), to find and remove defective tubers.

- Women in low-income group paid attention to the good properties of sweetpotatoes (purple peel, firm)

However, both groups of participants preferred sweetpotatoes that were not too big, oblong and stout.

Women often paid more attention to sweetpotato varieties (purple sweetpotatoes, Japanese sweetpotatoes, Vietnamese sweetpotatoes with yellow/white flesh) than men.

In addition, female students preferred processed sweetpotato products such as cocooned sweetpotatoes, snacks, sliced sweetpotatoes, etc., while the remaining women often preferred to buy raw sweetpotatoes to cook themselves.

- *Products from sweetpotatoes*

Respondents from both the male and female groups listed a large number of processing methods as well as products containing sweetpotato as ingredient.

Table 17. Processing methods and Products containing sweetpotatoes as ingredient

Male					Female				
Processing methods	**Users**	**Popularity**	**Sellers**	**Important features of the product**	**Processing methods**	**Users**	**Popularity**	**Sellers**	**Important features of the product**
Boil	Family, dieters		Users usually buy fresh sweetpotatoes to boil themselves. Fruit and vegetable counter in the supermarket. Market, but few.	Mealy, sweet	**Boil**	Old persons	Everywhere, easy to buy		The flesh is yellow like green beans when steamed. No water retention inside. Hot.
Grill	Students, public tourist sight	Commonly seen on roadside	Street food		**Grill**				
Fry	Students	Easy to find	Snack shops near schools	Crispy, sweet	**Fry**	Adults usually do not like fried food			Big pieces would be sweeter
Sweetpotato fritters	Students, few workers	Easy to find	Snack shops near schools	Sweetpotatoes are not important.	Fried sweetpotato flour cake			Sidewalk, near markets, near schools	Sweetpotato tastes sweeter

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	Some parents			Good dough is okay					
Dry	Everyone, even children, often for snacks	Less common	Only supermarket		Dry				
Soup					Sweetpotato flour				
Curry					Sweetpotato gruel	Everyone			Soft, good smell of sweetpotato, fleshy
Raw/Fresh					Eat it raw				

A man commented: "*There are boiled sweetpotatoes in the market but few people like others boiling for them. Choosing fresh sweetpotatoes to boil themselves would be safer.*"

- ***Process for preparing boiled sweetpotatoes***

Table 18. Process for preparing boiled sweetpotatoes

Male		Female	
Steps	Executor	Steps	Executor
1. Wash, select sweetpotatoes 2. Put in the pot so that the water covers the sweetpotatoes 3. Boil for about 10 minutes, then decant water (Before decanting, use a fork to skewer to see if the sweetpotato is soft, do not use chopstick because the sweetpotato is easily crushed – opinion of a participant who often cooks) 4. Leave a little water and then cover the pot, continue to boil for about 6-7 minutes to evaporate most of the water, let the remaining steam cook the sweetpotatoes.	Mother, sister or themselves	1. Wash to remove the soil 2. Cut off the 2 ends/cut off the damaged part 3. Shave peel off or not 4. Boil until cooked, use a toothpick to determine if sweetpotatoes are cooked or not 5. Drain the water until sweetpotatoes dry	Mother, grandmother, themselves, even father

Table 19. Gender-differentiated preferred characteristics for boiled sweetpotatoes

Male			**Female**		
Description of high quality boiled sweetpotato	*3 most important characteristics*	*How to recognize those characteristics*	*Description of high quality boiled sweetpotato*	*3 most important characteristics*	*How to recognize those characteristics*
Mealy, sweet Color must be even Must be soft Hot	- Sweet - Mealy - Soft	Need to eat to know	Good flavor, yellow bean color of flesh, no fiber, sweet, mealy. Light colored flesh Big roots Burnt tuber at the bottom of the pot	- Mealy - Sweet - Good smell and flavor	- Easy to break - Need to taste - Smell

Table 20. Gender-differentiated least preferred characteristics for boiled sweetpotatoes

Male		Female	
Description of low quality boiled sweetpotato	**How to recognize those characteristics**	**Description of low quality boiled sweetpotato**	**How to recognize those characteristics**
Over-boiled, cracked, not-well-cooked, Fibrous Bland, not sweet Not mealy Weevil damage Too powdery	Need to eat to know	Dark bruises inside Fibrous Wet on the surface Too mushy (due to boiling too long) Bitter Smell of alcohol after a long Had weevil damage	Observe Taste Smell Break and observe Eat Smell

Table 21. Reasons why consumers eat boiled sweetpotatoes

Male			Female		
Reason	**Usage & frequency**	**Level & reason of importance in diet**	**Reason**	**Usage & frequency**	**Level & reason of importance in diet**
Eat for fun, snack Diet, can eat instead of vegetables Snack after meal Tasty	Boiled sweetpotatoes are eaten alone, with nothing else Average 1-2 times/month	Sweetpotatoes are not very important	- Like to eat, easy to cook - Easy to buy, easier to cook than cassava, safer than cassava - Eat instead of rice to lose weight - Cheap, suitable for snacks - Simple cooking, just boil sweetpotatoes, no need to eat with other things (unlike rice)	Boiled sweetpotatoes are usually eaten alone, with nothing else Fried sweetpotato flour cake Average 1-2 times/month	Great as snacks, Very cheap if bought at wholesale markets Can be replace totally Sweetpotato fritters good as snack Good for health, especially digestion, good starch, helps to lose weight

Table 22. Ideas for new innovative products to be launched in the market"?

Male	Female
Sweetpotatoes mixed with flour to make cakes Sweetpotatoes with edible peels	Pasta from sweetpotatoes (noodles, vermicelli, pho) Bread made from sweetpotato Ready-to-eat baked sweetpotatoes, consumers just need to reheat and consume at any time Sweetpotato without peel

There was an opinion that: *"If sweetpotatoes can be cooked into many dishes like rice, people would switch to eating more sweetpotatoes."*

3.1.3. Consumer Test

Liking score for sweetpotato products

The results of the analysis of variance showed a statistically significant (p<0.001) difference between the sweetpotato varieties' average liking scores for four aspects: General liking, Appearance liking, Smell and flavor liking, Texture liking.

Beniazuma was the sample with the highest preference score, followed by sweetpotato imported from China and Khoai Bo. However, Beniazuma and sweetpotato imported from China had no significant difference in mean score (group c).
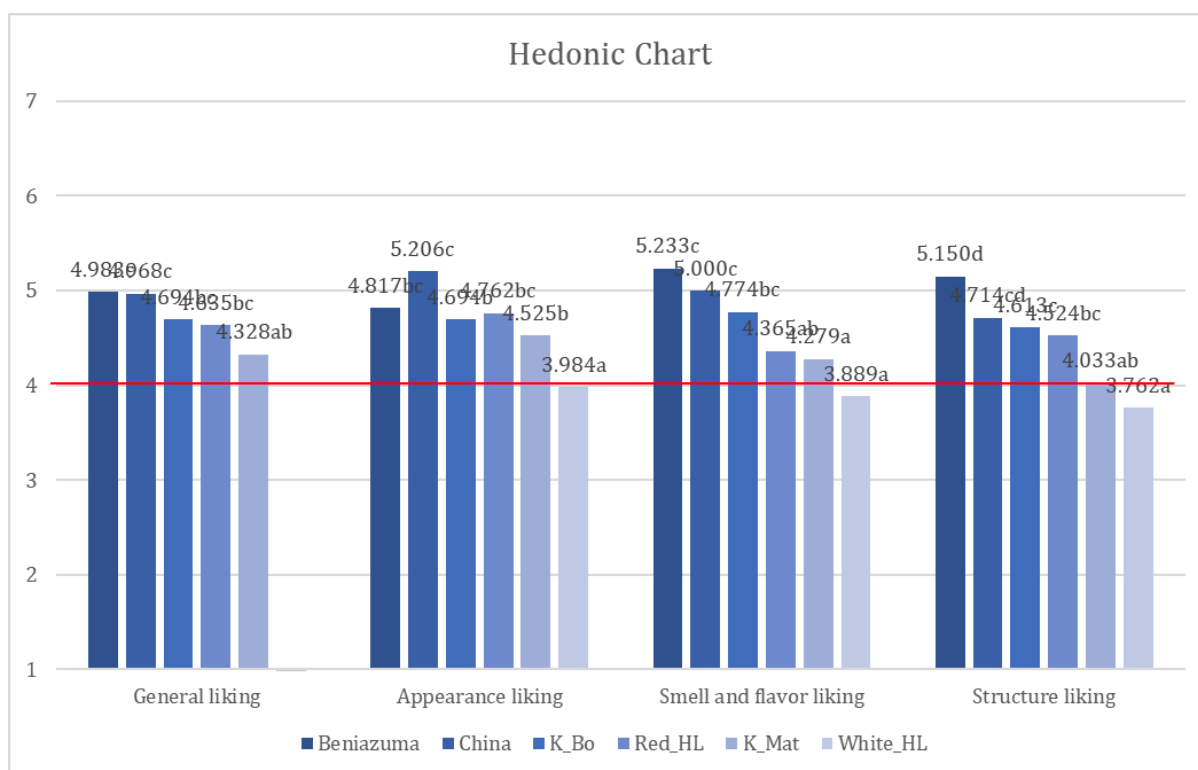
Figure 13. Average liking scores for the six sweetpotato varieties

Looking deeper into the boxplot chart, we found that:

- 75% of respondents rated samples of Red Hoang Long, Beniazuma, Khoai_Bo, and Chinese Sweetpotato in their liking region (>4 points)
- 50% of respondents rated the White Hoang Long sample below the acceptable range (<4 points).
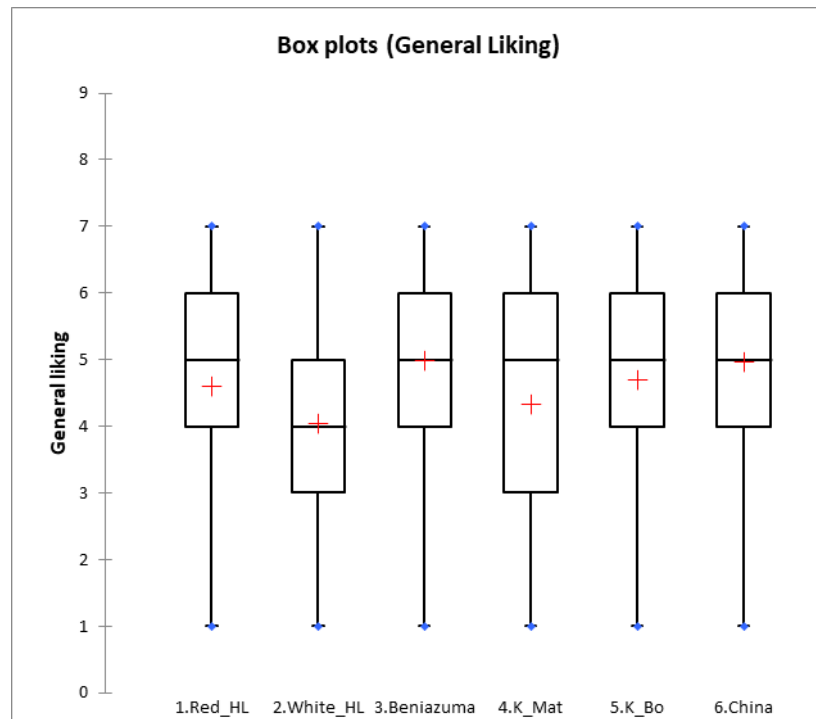
Figure 14. Boxplot chart of general liking

The Khoai_Mat sample showed high heterogeneity. While 50% of panelists had positive feelings about the product (> 5 points), 25% of panelists thought the product was bad (< 3 points). That lowered the average liking score of the product far from the median.
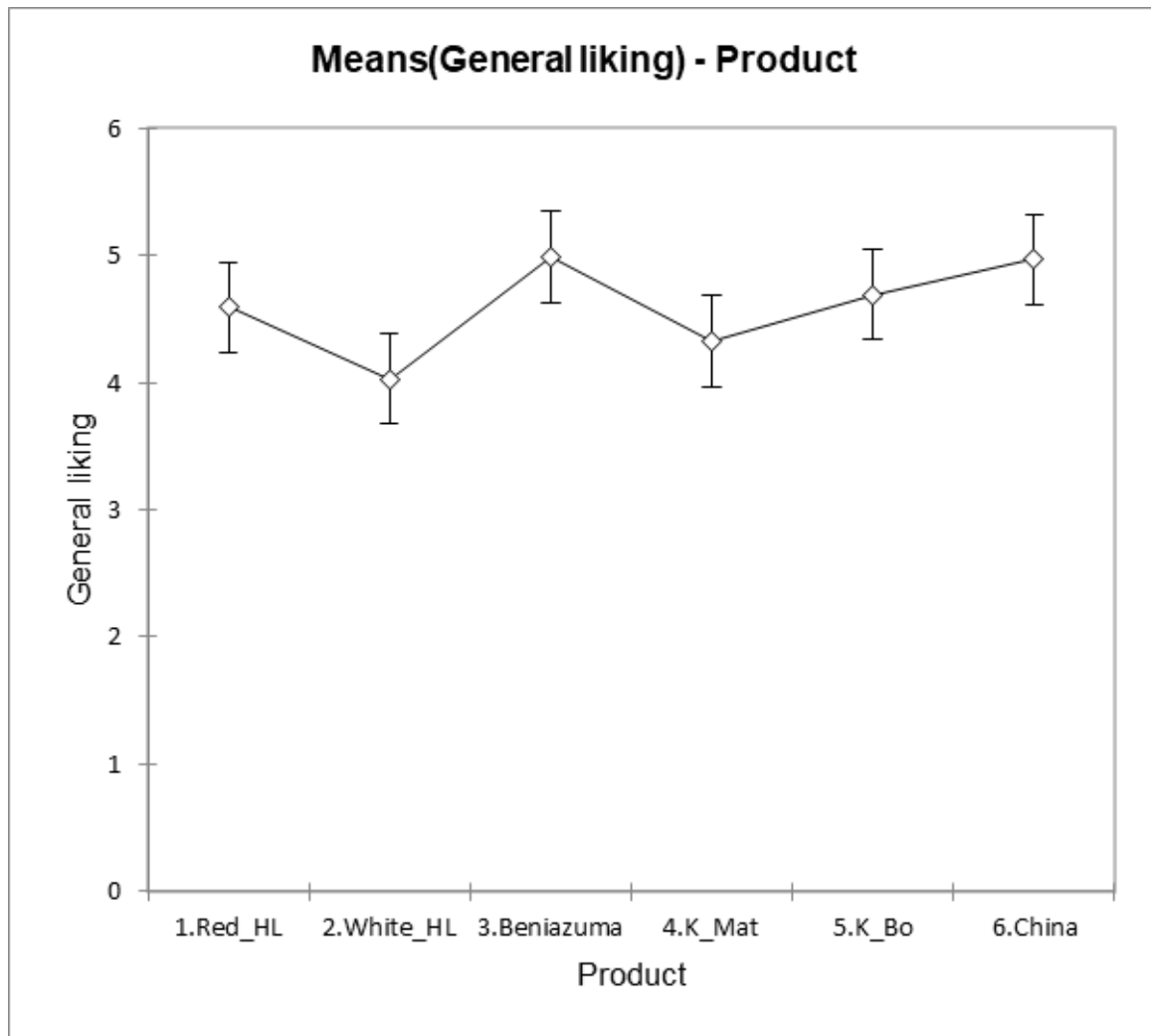
Figure 15. Means of the six sweetpotato products' general liking

Relationship between the liking scores/preference patterns and the gender and socioeconomic background of consumers

- The Hierarchical cluster analysis (HCA) permit to cluster participants into three groups of similar preference patterns
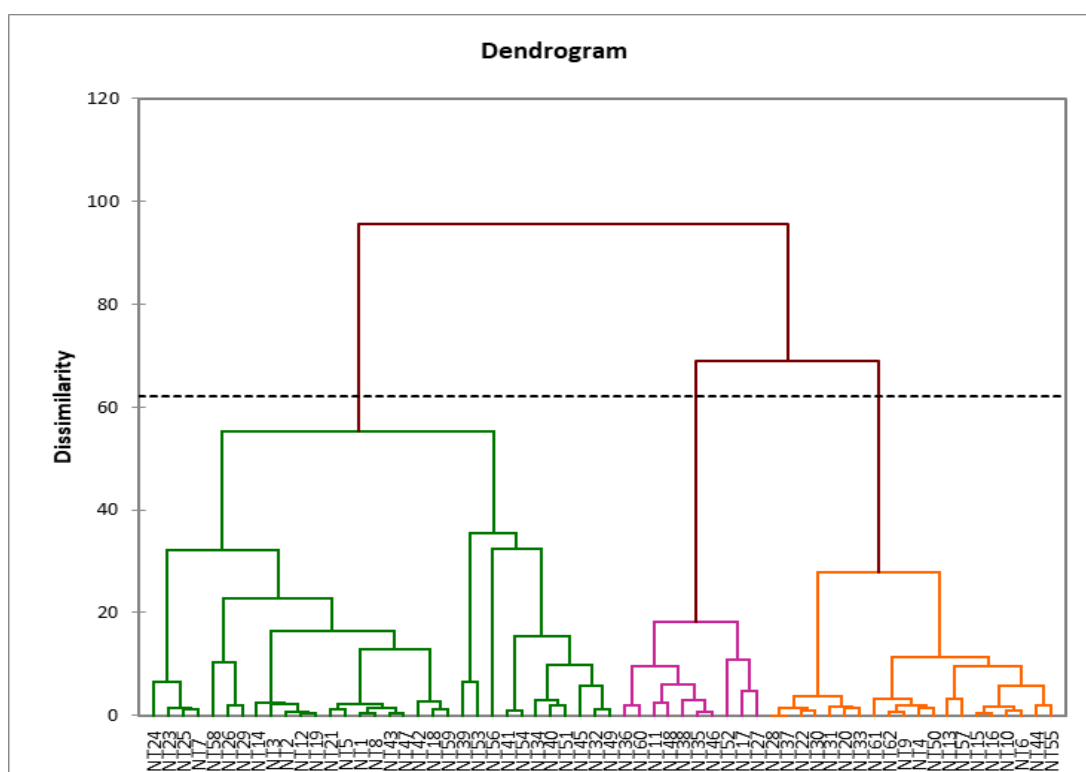
Figure 16. HCA results of three consumer segmentations

Table 23. Preference patterns of three consumer clusters

Groups	Beniazuma	China	K_Bo	Red_HL	K_Mat	White_HL
1	5.124	4.250	4.271	4.126	3.809	3.660
2	5.850	5.650	5.269	5.170	4.892	4.949
3	2.800	5.800	5.353	5.151	4.452	4.056

There were differences between group 1 and group 3 because group 1 preferred Beniazuma the most while group 3 liked it the least. Group 2 has similar high preferences for Beniazuma and China varieties. This group also showed a tendency to indicate higher scores than the other groups.

Table 24. Characteristics of each consumer group

		Group 1	Group 2	Group 3
Age	18-23	57%	45%	20%
	24-30	3%	5%	10%
	31-40	25%	20%	30%
	>40	16%	30%	40%
Gender	Male	25%	15%	10%
	Female	76%	84%	89%

51

		Group 1	Group 2	Group 3
Incomes (VND)	<3m	57%	45%	0%
	3-4.5m	6%	10%	0%
	4.5-7.5m	6%	5%	0%
	7.5-15m	28%	30%	20%
	15-30m	3%	5%	40%
	>30m	0%	5%	40%
Marriage situation	Single	63%	50%	40%
	Married and has children	28%	45%	60%
	Married and has not children yet	6%	5%	0%
	Other	3%	0%	0%
Yellow cells: the main demographic characteristics of consumer groups				

Table 24 shows that group 1 was representative of the young participants with low income and singles. While group 3 was representative of the middle-age participants with high income and married. The group 2 may be representative for all participants because it was mixed between young and old, low and middle incomes, single and married participants.

- The preference mapping

Otherwise, figure 17 shows results of the external Preference mapping of 3 consumer clusters and sweetpotato samples. The cluster 1 presents China sample with the percentages of preferred assessors for this sample 67%. The cluster 2 presents K_Bo and K_Mat with the percentages of preferred assessors for this sample 33%. The cluster 3 presents the three other samples with the percentages of preferred assessors for Red_HL sample 67%.
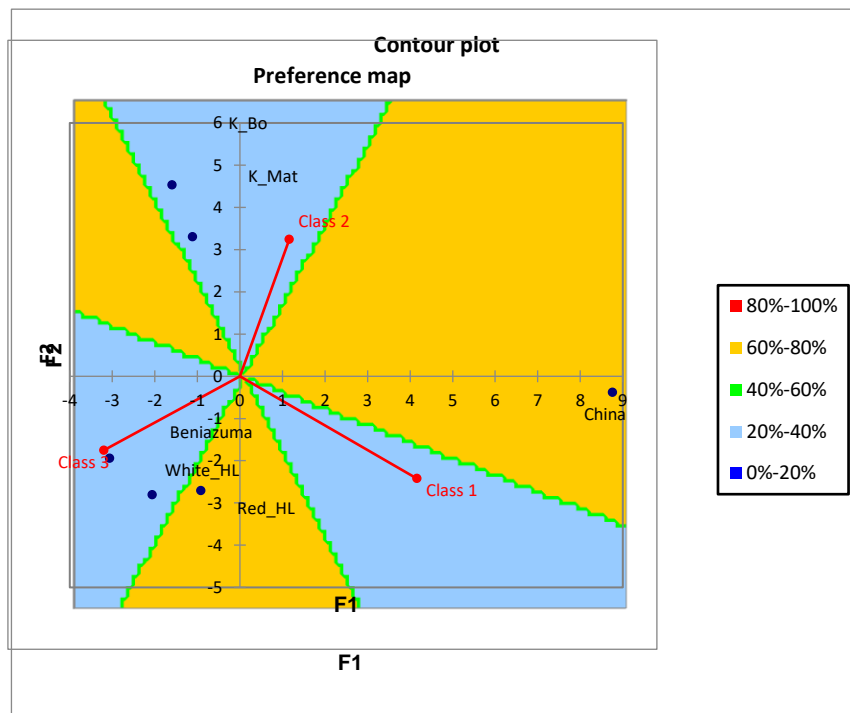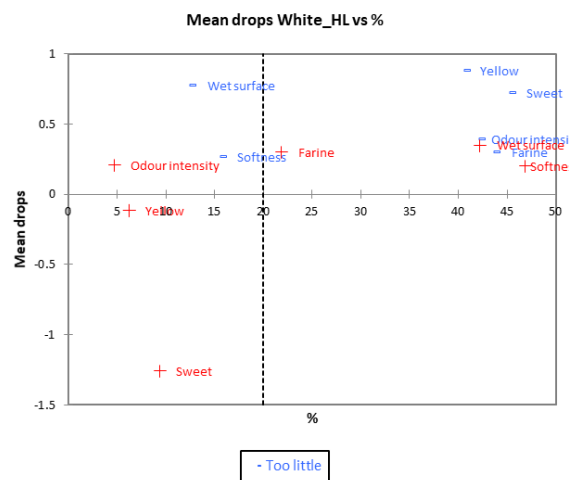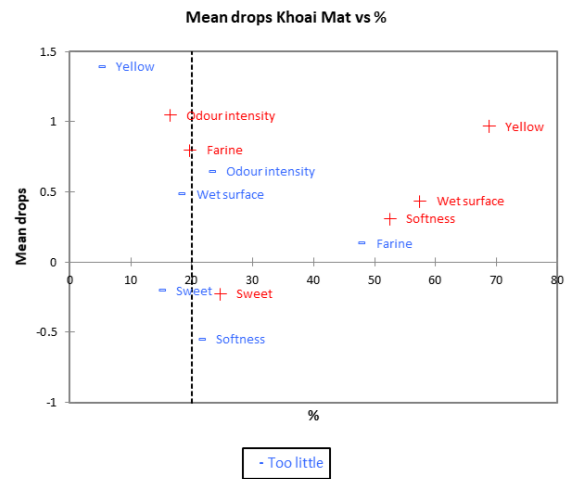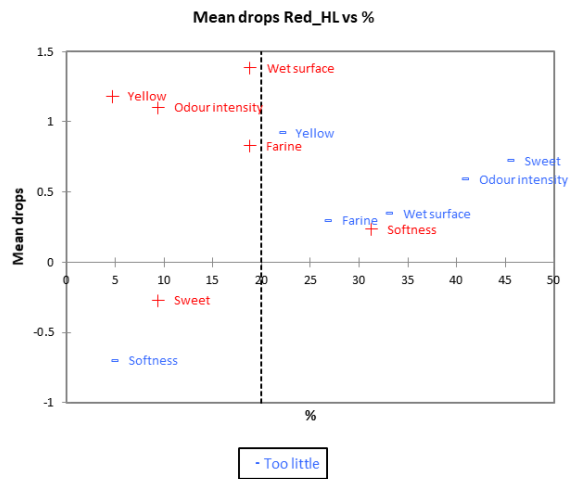
Figure 17. External Preference mapping of sweetpotato samples

JAR scale results

The JAR analysis on each product allowed us to determine the optimum level of intensity of some sensory descriptors. The results can inform product improvement according to consumers' perception. Penalty Analysis was applied, based on the relationship between intensity score of the attributes given on the JAR scale and the preference score for that product. The difference in the JAR score was only significant when it reduced the overall liking score in a statistically significant way.

- *All varieties*

Mean drops Red_HL vs %

Mean drops Khoai Mat vs %

Mean drops White_HL vs %

Mean drops Khoai Bo vs %

Mean drops Beniazuma vs %

Mean drops China variety vs %

54
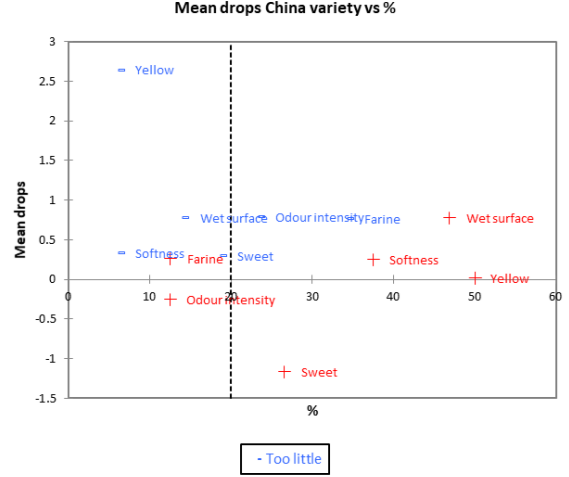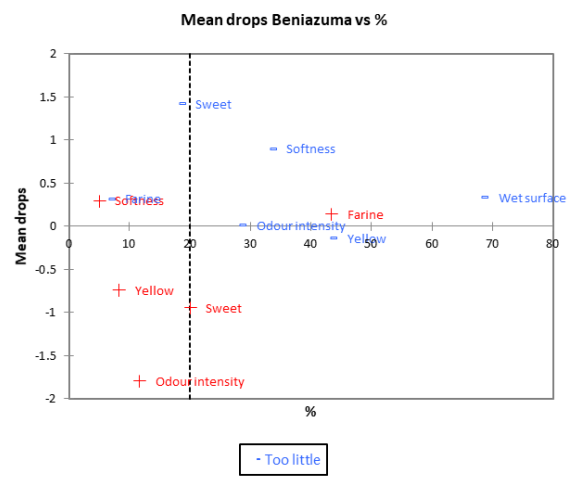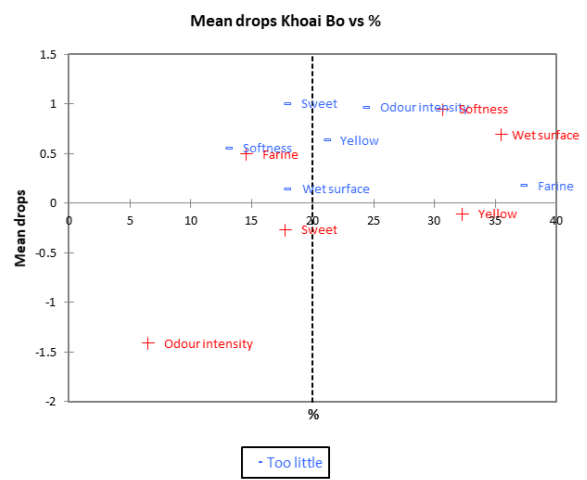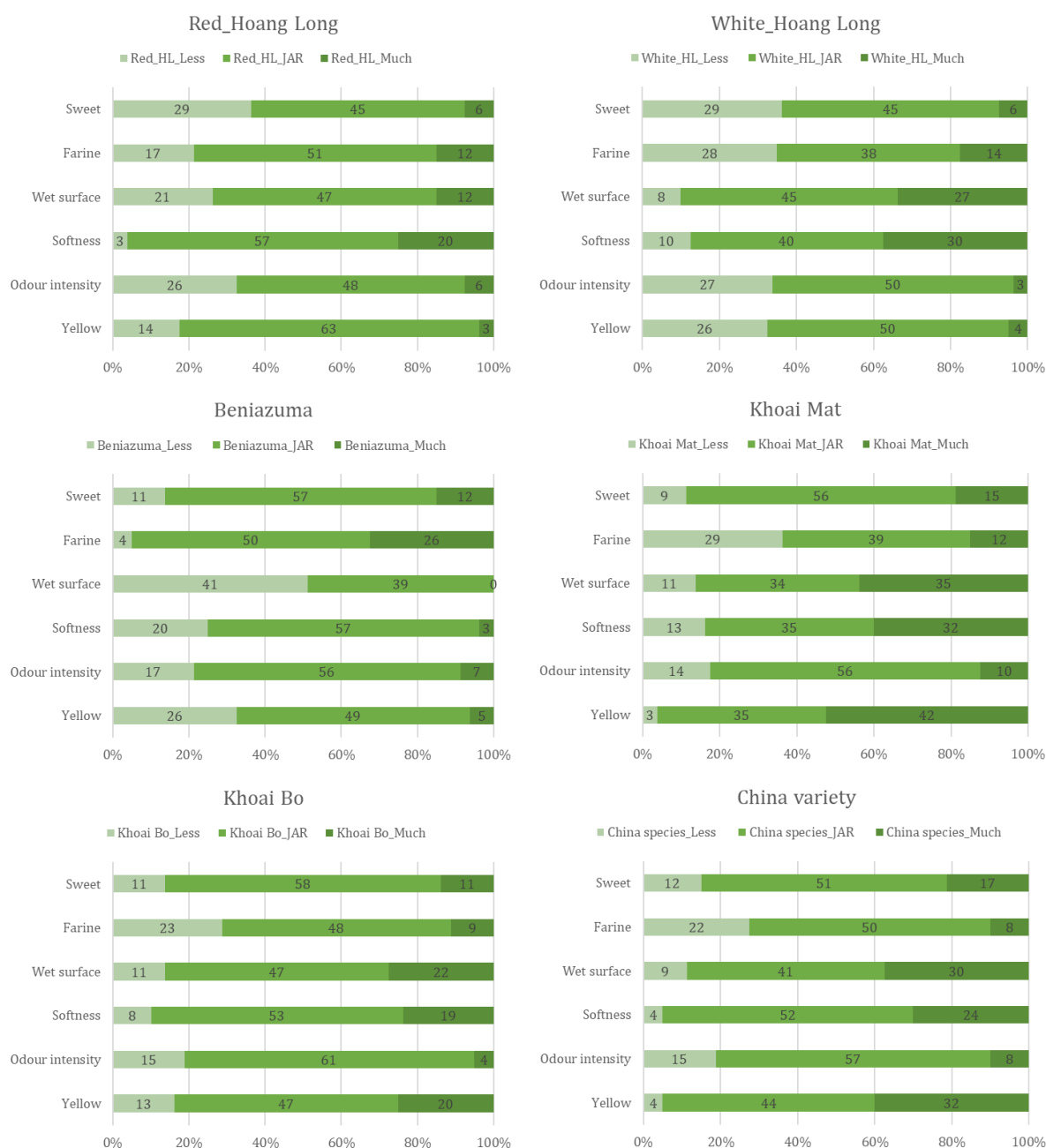
Figure 18. Penalty analysis of all the varieties in one graph

- *Red Hoang Long*

In the JAR analysis, six attributes were considered, namely: Yellow, Color intensity, Odor intensity, Softness, Wet surface, Mealy and Sweet.

- The **Level** column presents three intensity levels. Then, the **Frequencies** column shows the number of panelists that selected each level. Here, *14 people (22%) thought that yellow color of Red Hoang Long sample was low; 47 people (73%) gave Just about right level; and three people (5%) thought yellow was much.*

- The **Sum (General liking)** column shows the total general liking scores of individuals at the respective level. *For example, the 14 people who thought that yellow color of Red Hoang Long sample was low had a total of 55 general liking scores. Divide that number 55 by 14, we got 3,929* – the value of the next column: **Mean (General liking).**

- The **Mean drops** column shows the average number of points lost when panelists selected non-JAR levels. Based on the example above, compared with people who perceived yellow as Just about right, those who felt yellow was low indicated a liking score for the product which was on average 0.922 points lower.

- Finally, the **Significant** column indicates whether the reduction in **Mean drops** is statistically significant. Note: Only non-JARs >20% were examined further. For instance, although the ones who thought that the yellow color was much caused

the drop of 1,184 points, this case was not processed further because only three (<5%) indicated so.
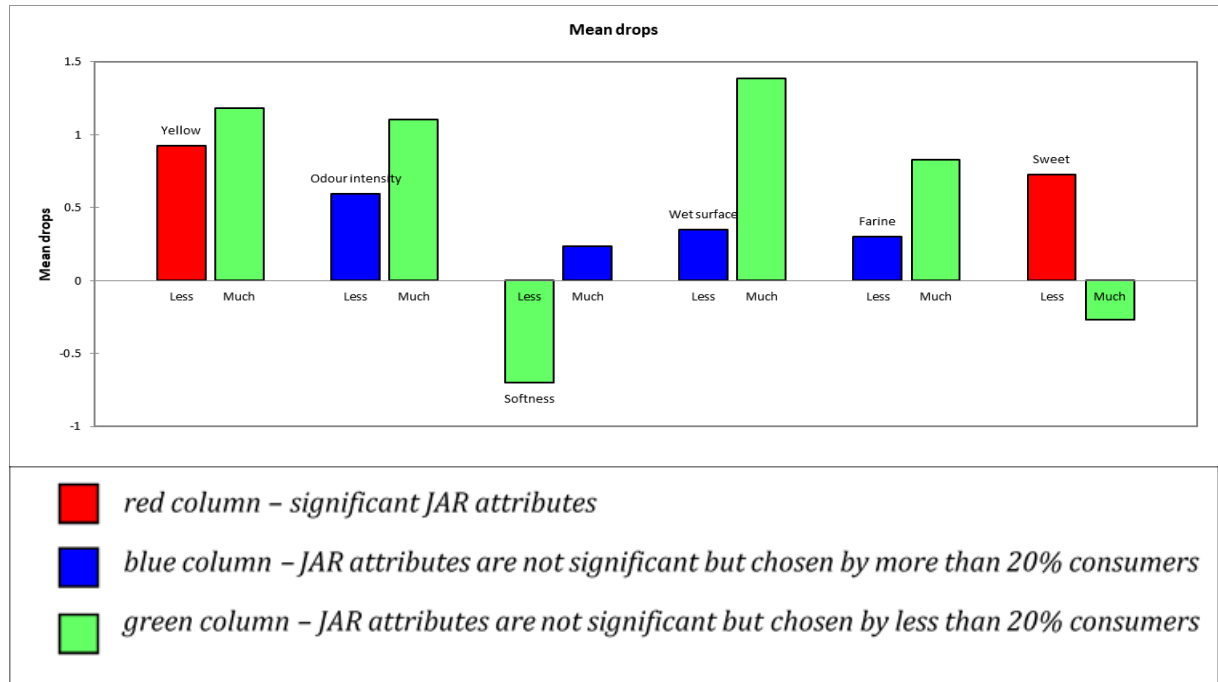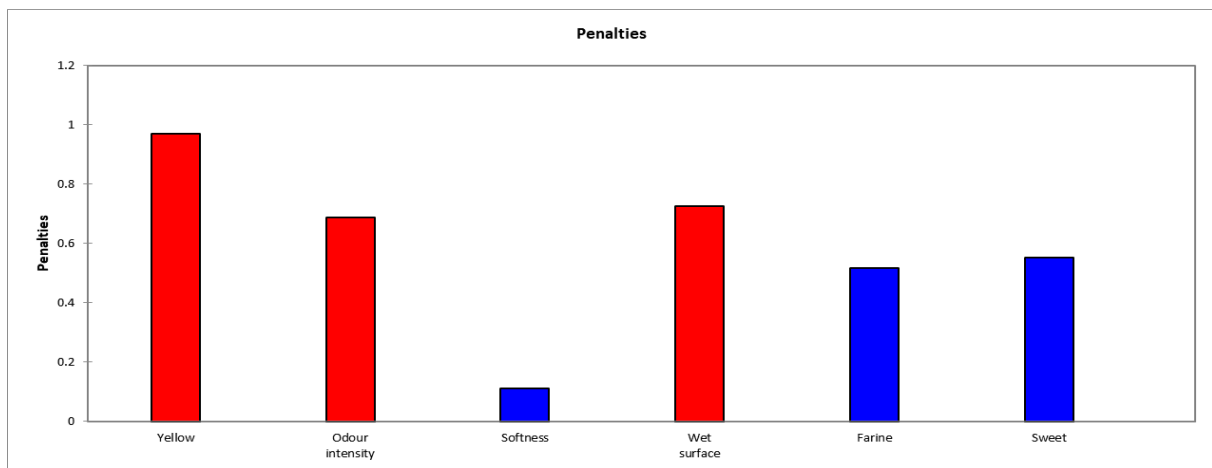

Figure 19. MeanDrop chart of Red Hoang Long

Figure 20. Penalties Chart of Red Hoang Long

➔ Using a critical level of 20% respondents and 0.5 mean drop, figure 37 showed that only *yellow* and *sweet* are significant attributes. Hence, following figure 38, we should adjust to increase Yellow-color and Sweetness.
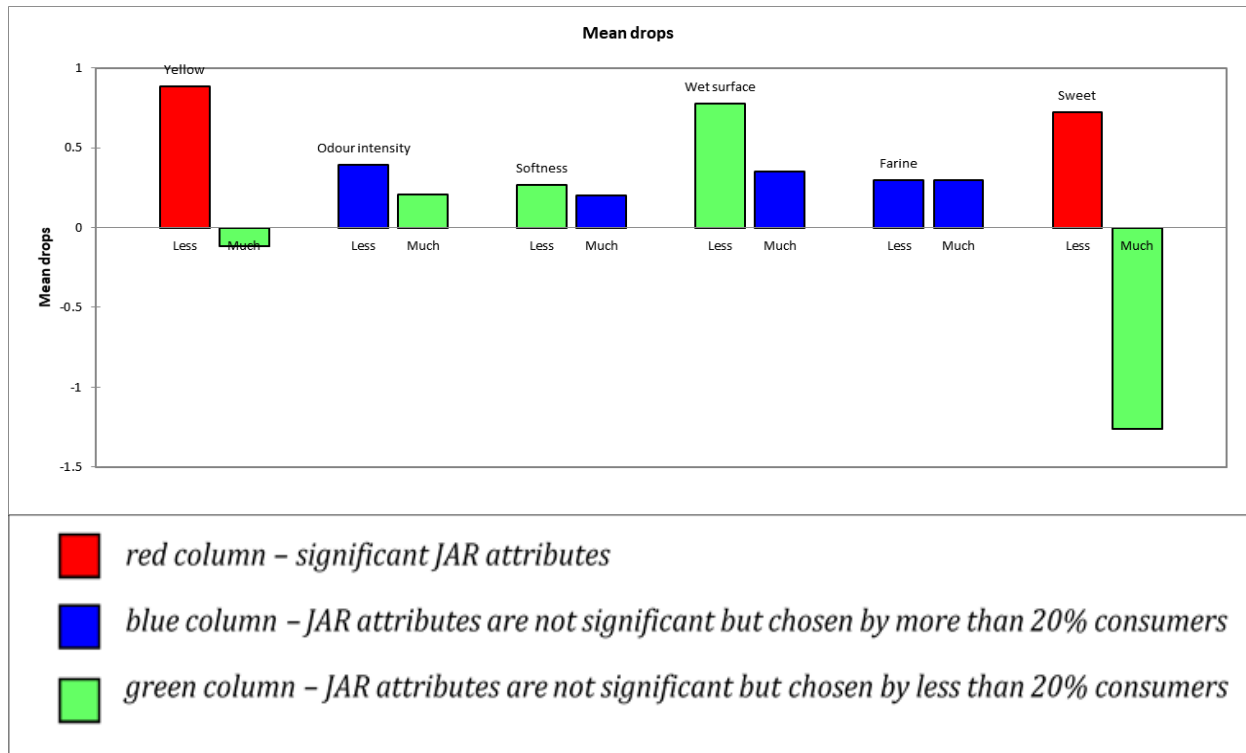
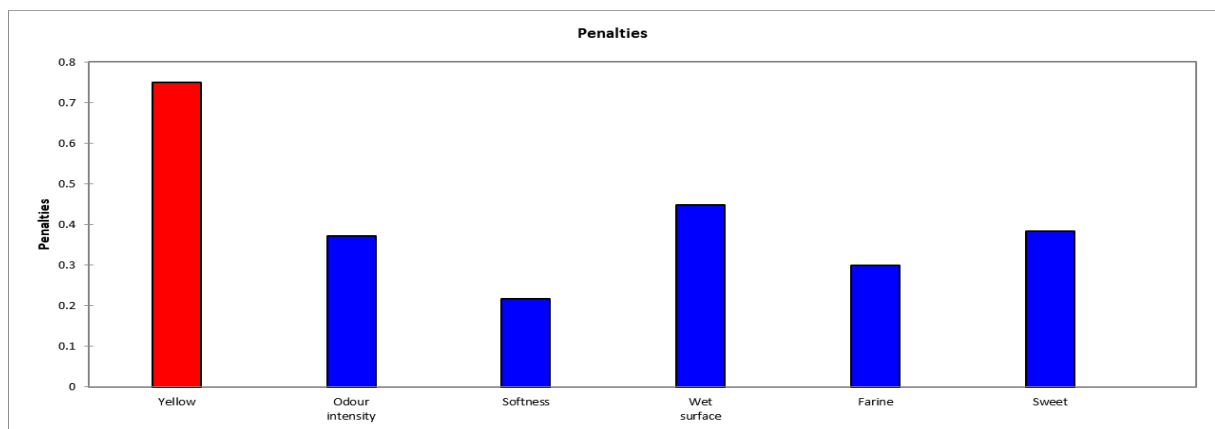- *White Hoang Long*

Figure 21. Meandrop chart of White Hoang Long

Figure 22. Penalties chart of White Hoang Long

➔ Similarly, we should increase *yellow* and *sweet* properties.
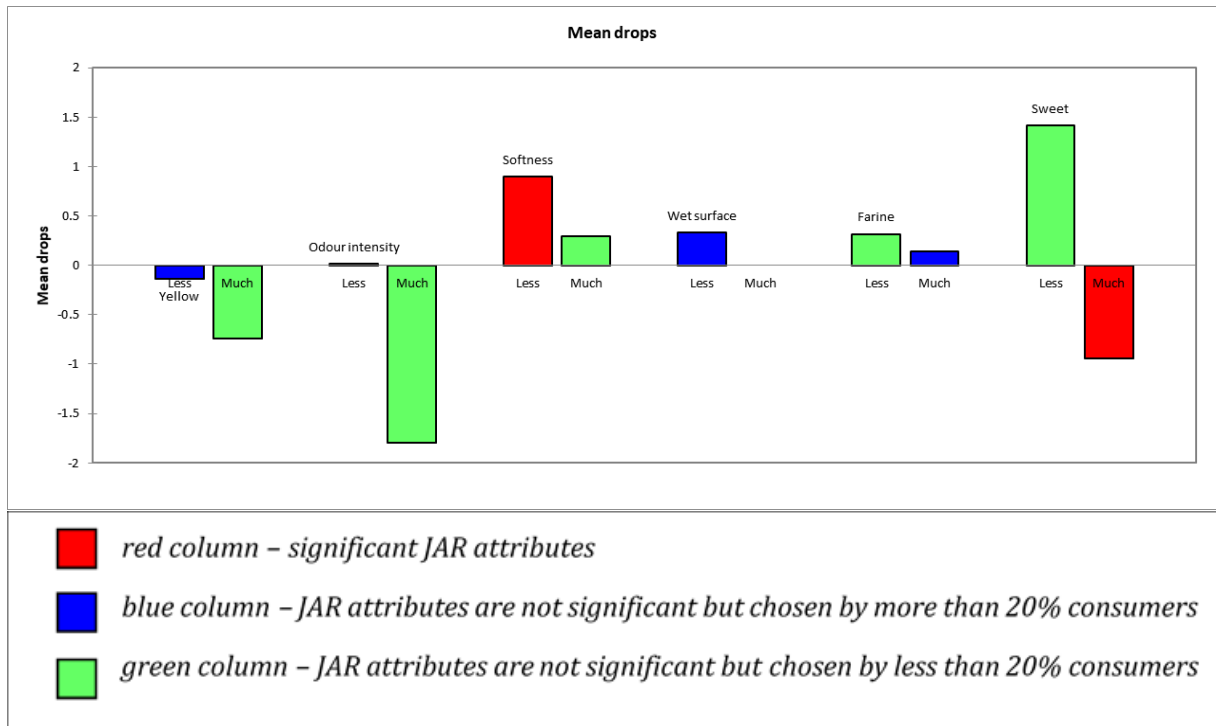
- *Beniazuma*
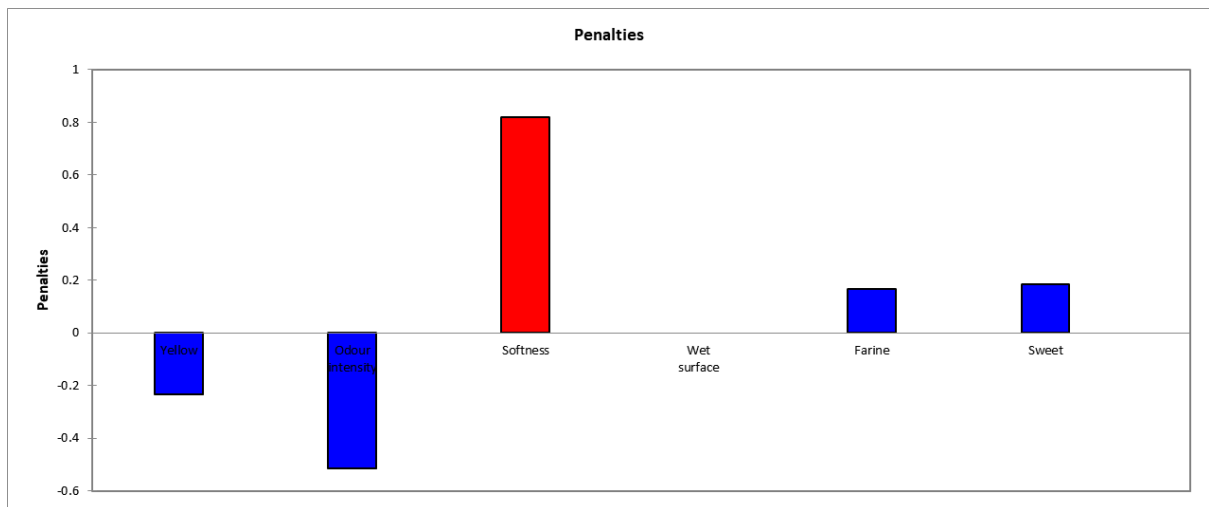

Figure 23. Meandrops chart of Beniazuma

Figure 24. Penalties chart of Beniazuma

➔ It was necessary to adjust to increase *softness* to improve hedonic scores. In summary, we had attributes that need to be adjusted in the products as presented in table 25.

Table 25. Summary table of attributes needed to be adjusted in sweetpotato samples

Sample	Attribute	Meandrop	Sig.
Red Hoang Long	Yellow (low)	0.922 (=4.851-3.929)	Yes (p=0.021)
Red Hoang Long	Sweet (low)	0.724 (=4.897-4.172)	Yes (p=0.043)
White Hoang Long	Yellow (low)	0.882 (=4.382-3.5)	Yes (p=0.014)
White Hoang Long	Sweet (low)	0.724 (=4.241-5.500)	Yes (p=0.040)
Beniazuma	Softness (low)	0.897 (=5.297-4.4)	Yes (p=0.026)

CATA results

A CATA mapping shows the specific characteristics of each sample by observing the frequencies of citation of sensory & perception descriptors (CATA table). From the results of a correspondence analysis (CA) performed on the CATA dataset, we divided the product set into four main groups. Figure 25 showed the position of samples following the similarity of sensory properties. The more samples are near to others, the more they are similar. And all descriptors, which are around each sample, are characteristic by that sample. Hence, four group have different specific characteristics.

- Group 1: White Hoang Long. This sample is characterized by *Dissolving, Yellow peel, Dislike, Immature-smell, Discomfort, Sour, Smoky, Rotten smell.*

- Group 2: Red Hoang Long. It is *throat-tightness, Roughly, Sweetpotato-smell, Sweetpotato-taste, Yellow-inside-as-bean.*

- Group 3: Beniazuma. It is characterized by *Crumbly, Starchy-smell, Fine-surface, Comfort-smell, Familiar, Natural, Starchy-taste, Brown-peel, Easy to eat, Delicious.* Followiing the focus groups discussion, *comfort-smell* is known as *natural, familiar, just-about-right intensity, and harmony.*

- Group 4: China, Khoai Bo, Khoai Mat samples have some similarities, such as *hard to remove peel, Honey-smell, Yellow-inside-as-turmeric, Eye-catching.*
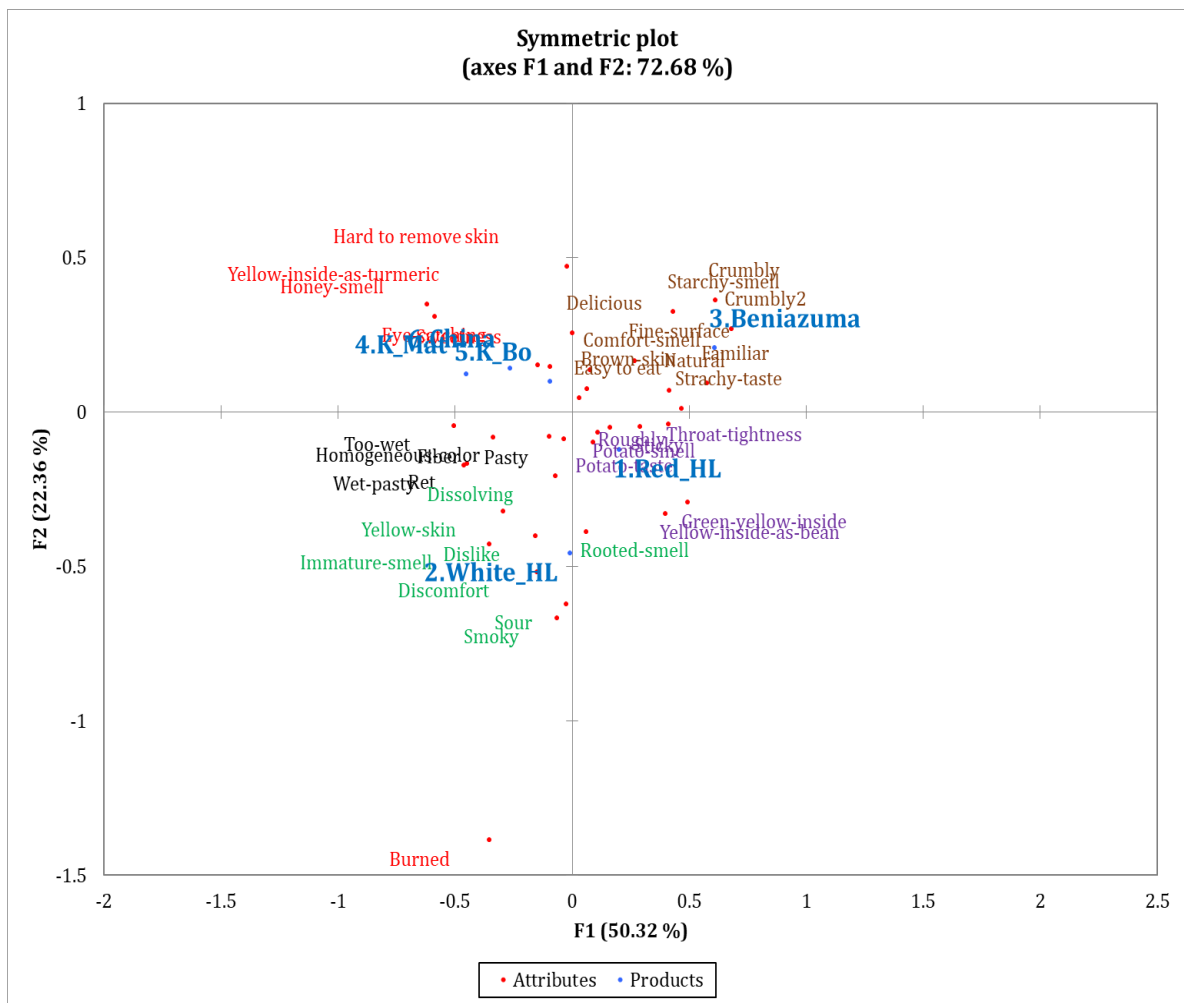
Figure 25. Sweetpotato products space and properties described by consumer panel

3.2. Part B – Results of research on Potatoes

3.2.1. *Quantitative Descriptive Analysis*

List of attributes

After a reduction following ISO 11035:1994, a list of 36 attributes were used for the QDA test. All potato's attributes are listed in table 26.

Table 26. Potato's descriptors

Groups of attributes	Attributes		
Appearances	SF_Sticky	P_Yellow	IN_Homogenous
	SF_Dry	P_Brown	IN_Transparent
	SF_Mealy	P_Red brown	IN_Yellow
	SF_Shine	P_Green yellow	IN_White
	SF_Fine	P_Smooth	IN_Green yellow
	P_Sprouted		
Odor and Flavor	O_Intensity	O_Starch	O_Fresh potato
	O_Cooked potato	O_Immature	O_Rooted
Taste	T_Sour	T_Umami	T_Greasy
	T_Sweet	T_Cool	
Structure	ST_Liquid	ST_Fine	ST_Tender
	ST_Viscous	ST_Sticky	ST_Soft
	ST_Mealy	ST_Soluble	ST_Uncooked

Note: SF= surface; P = peel; IN = inside; O = odor and aroma T = Taste; ST=structure

Table 27. Definition of final descriptors in Potatoes

		Characteristics	Evaluation
1		SF_Sticky	Using index finger press gently the potato and lift it up slowly. The finger is released faster, the lower sticky and reversely.
2		SF_Dry	
3		SF_Mealy	
4		SF_Shine	
5	**Appearance**	SF_Fine	
6		P_Sprouted	
7		P_Yellow	
8		P_Brown	
9		P_Red brown	
10		P_Green yellow	
11		P_Smooth	

		Characteristics	Evaluation
12		IN_Homogenous	
13		IN_Transparent	
14		IN_Yellow	
15		IN_White	
16		IN_Green yellow	
1	**Flavour**	O_Intensity	Breaking a potato or mashing it by two fingers and smell it. Assessing overall the odour intensity. Very strong odour intensity will be feel strong.
2		O_Cooked potato	Characteristic flavour of cooked potato
3		O_Starch	
4		O_Immature	Smell of solanine in potato
5		O_Fresh potato	Flavour of uncooked potato
6		O_Rooted	
7		T_Sour	
8		T_Sweet	
9		T_Umami	
10		T_Cool	
11		T_Greasy	
1	**Structure**	ST_Liquid	Using tongue press gently the potato on the palate, feel the water content of potato. More water in potato, more liquid
2		ST_Viscous	Using hands to roll the potato into pellets. If time is low for making pellet easily, the viscous is high and reversely.
3		ST_Mealy	Using hands to break potato into 2 pieces and observe the surface: starchy, loose and less water. Eating a piece of potato and using tongue to feel the fragmentation and dryness of potato. The faster potato fragile, the looser it is, the less water it gets, the more it is mealy.
4		ST_Fine	Using tongue to press a piece of potato into front teeth, panning back and forth to feel the fragments. If fragment's side is similar and dissolvable, potato is fine. If fragment is not dissolvable, potato is not fine.
5		ST_Sticky	Potato is placed between your teeth, lift it up and down to feel sticky between teeth. The easier teeth lift it off, the stickier and reversely.
6		ST_Soluble	Using tongue to press the potato into the roof of mouth, estimate the time potato dissolve on tongue. The faster it dissolves, the more soluble and reversely.
7		ST_Tender	Chewing potato and using tongue to mix potato in month and feel the sticky of potato. The stickier, the more tender and reversely.

		Characteristics	Evaluation
8		ST_Soft	Using index finger to press potato with the same force. The easier potato sink, the softer potato is and reversely.
9		ST_Uncooked	Chewing potato and feeling its grit (due to different hard and soft parts in potato mass)

Note: SF= surface; P = peel; IN = inside; O = odor and aroma T = Taste; ST=structure; There are some descriptors that are easy to be understood by panel, so we have not their definitions.

After the generation of final descriptor list, the panel discussed together to find out the definition of descriptors. Then, they were asked to evaluate the intensity of each descriptors on a scale from 0 to 10 (0 = no found that characteristic, 1 = very weak intensity, 10 = very strong intensity).

Product positioning and sensory map

A 36-attribute-dataset is analysed by Principal Component Analysis – PCA to demonstrate products and attributes mapping:

First 2D space is chosen to project product space is F1-F2, this space contains the most information of product space (59,53%). In this space, more than a half of product attributes are demonstrated well, except: *SK_yellow green, SK_Sprout, SK_Brown, SK_Red brown, O_Uncooked, O_Smell intensity, Sticky.*
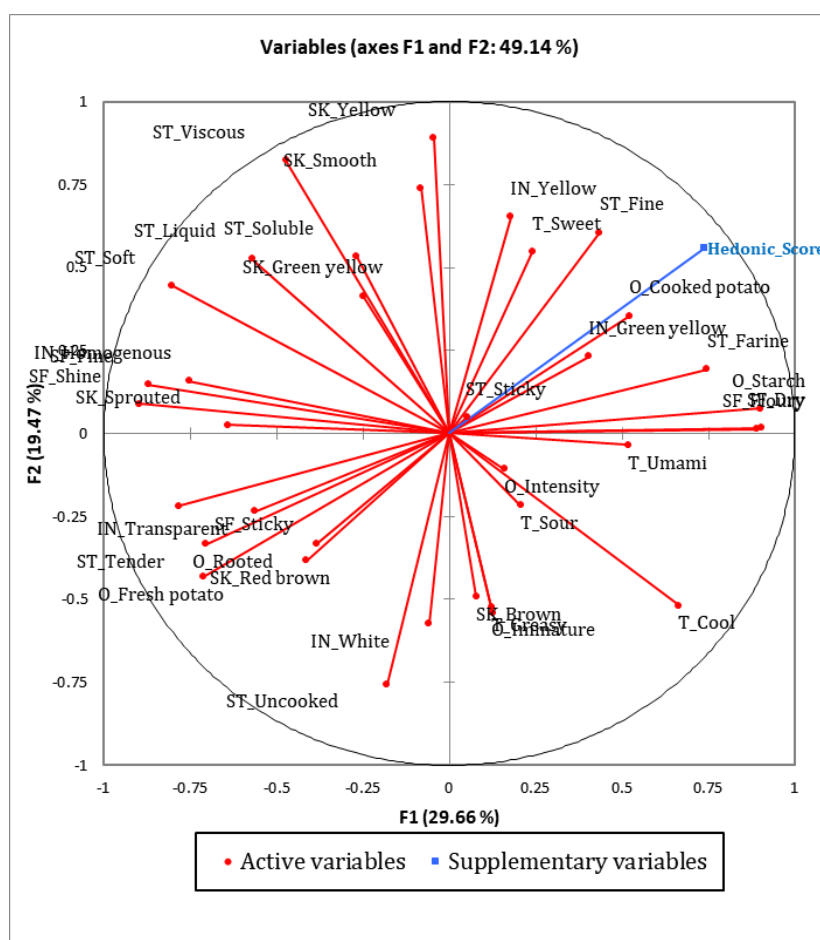
Figure 26. Variables circle with hedonic score as supplementary variable (F1-F2)

From Figure 26, attributes are classified into 4 groups:

- Group 1: T_Sweet, ST_Fine, IN_Yellow, SK_Smooth, ST_Soluble, ST_Viscous, SK_Yellow

- Group 2: ST_Uncooked, IN_White, SK_Brown, T_Greasy, O_Immature (this group is inversely correlated with group 1)

- Group 3: ST_Liquid, ST_Soft, IN_Homogeneous, SF_Fine, SF_Shine, SF_Sticky, Uncooked, ST_Tender, IN_Transparent

- Group 4: ST_Mealy, O_Cooked potato, O_Starch, SF_Dry, SF_Starch, T_Cool, IN_Yellow green, T_Umami (this group is inversely correlated with group 3)

F1-F3 space confirm the classification (Figure 27). In addition, hedonic score is strongly associated with group of attributes that include: O_Cooked potato, IN_Green yellow, ST_Fine, ST_Mealy, SF_Dry, SF_Mealy.
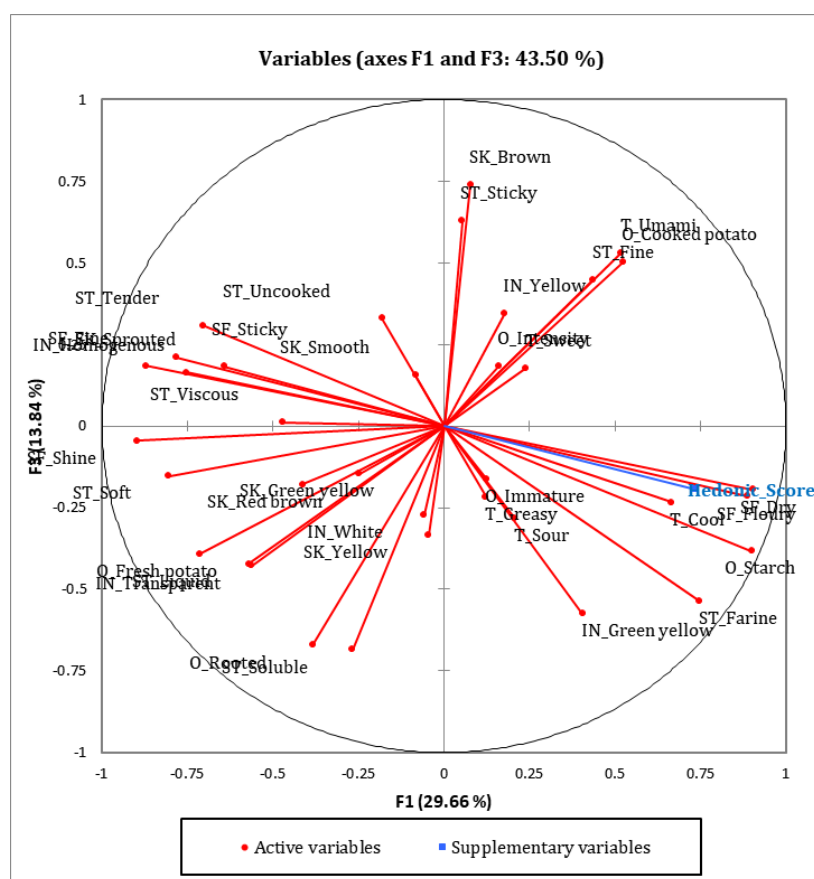
Figure 27. Variables circle with hedonic score as supplementary variable (F1 - F3)

Finally, the products (observation) were represented on the map (F1, F2) as shown below. The closer a product was to any major axis, the better it was to be represented by that axis. Besides, products are classified into 5 group basing on biplot of products space and variables circle (F1-F2, F1-F3) (Figure 28 and Figure 29). Hence, we can observe the specific characteristics of each product of group of products as shown in table 28.

Table 28. Potato and their typical characteristics (PCA)

Group	Products	Typical characteristics
1 (F1-2)	Solara, KT1	T_Sweet, ST_Fine, IN_Yellow, SK_Fine, ST_Soluble, SK_Yellow
2 (F1-2)	KT6, KT4	ST_Liquid, ST_Soft, ST_Homogenous, SF_Fine, SF_Shine
3 (F1-2)	No.3	ST_Uncooked, IN_White, SK_Brown, T_Greasy, O_Immature
4 (F1-2)	Marabell. KT5	IN_Yellow green, ST_Mealy, O_Starch, SF_Dry, SF_Floury, T_Umami
5 (F1-3)	No.1, No.10	SK_Fine, ST_Uncooked, IN_Yellow, SK_Brown, ST_Sticky
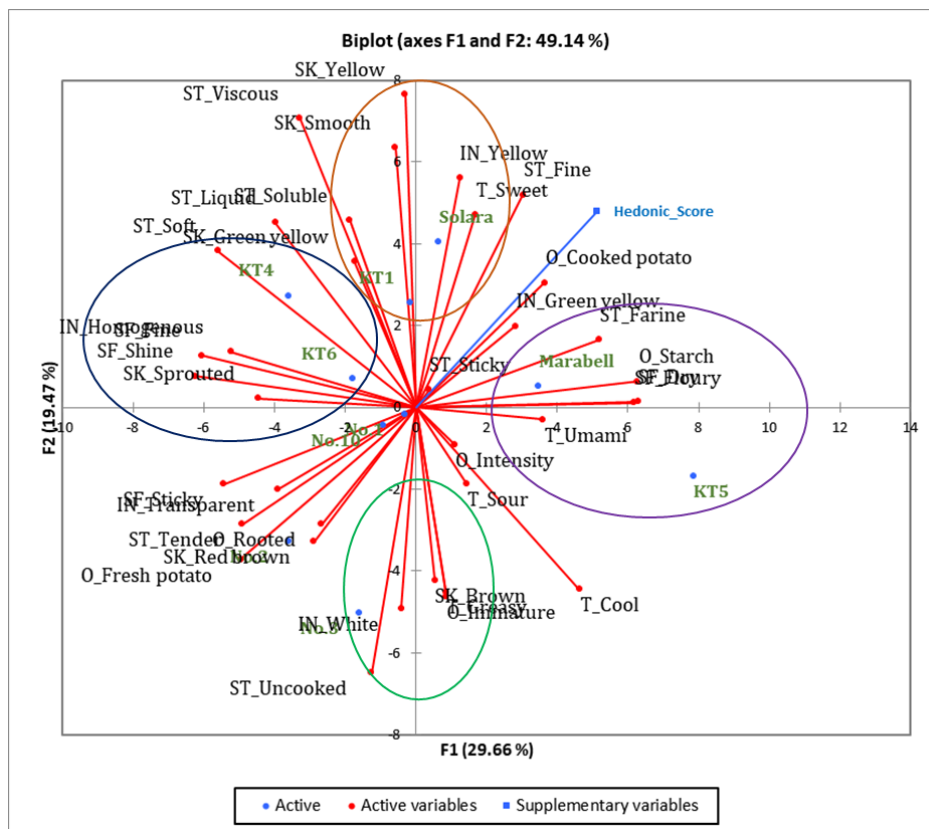
Figure 28. Biplot of products space and variables circle (F1-F2)
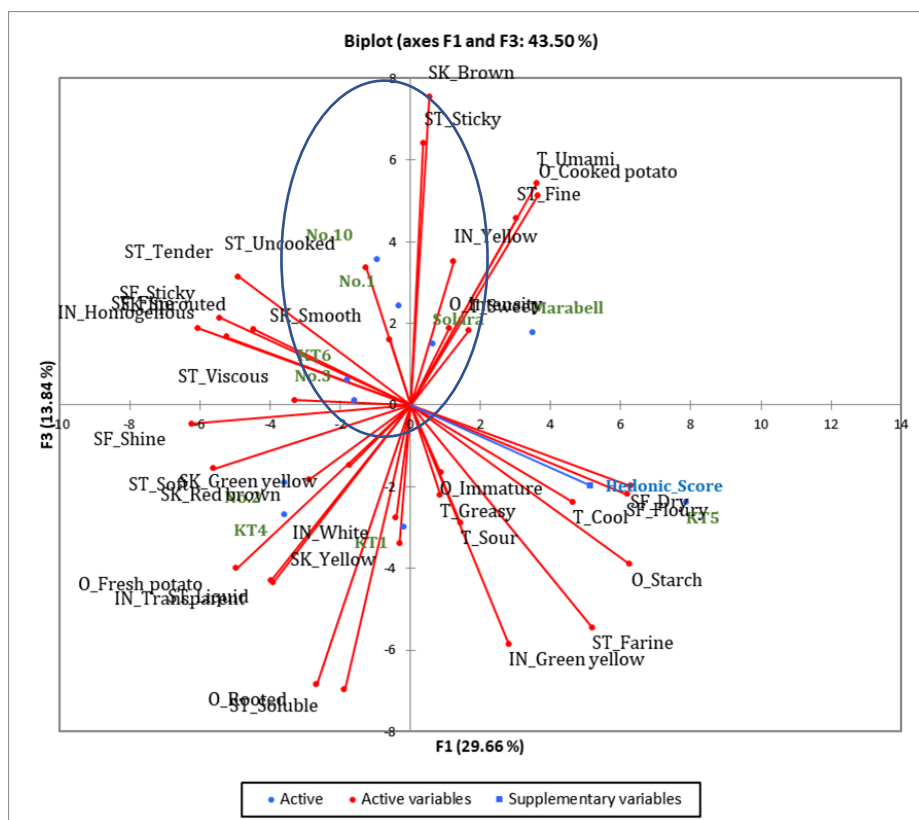
Figure 29. Biplot of products space and variables circle (F1-F3)

67

3.2.1.1. *Product profiles*
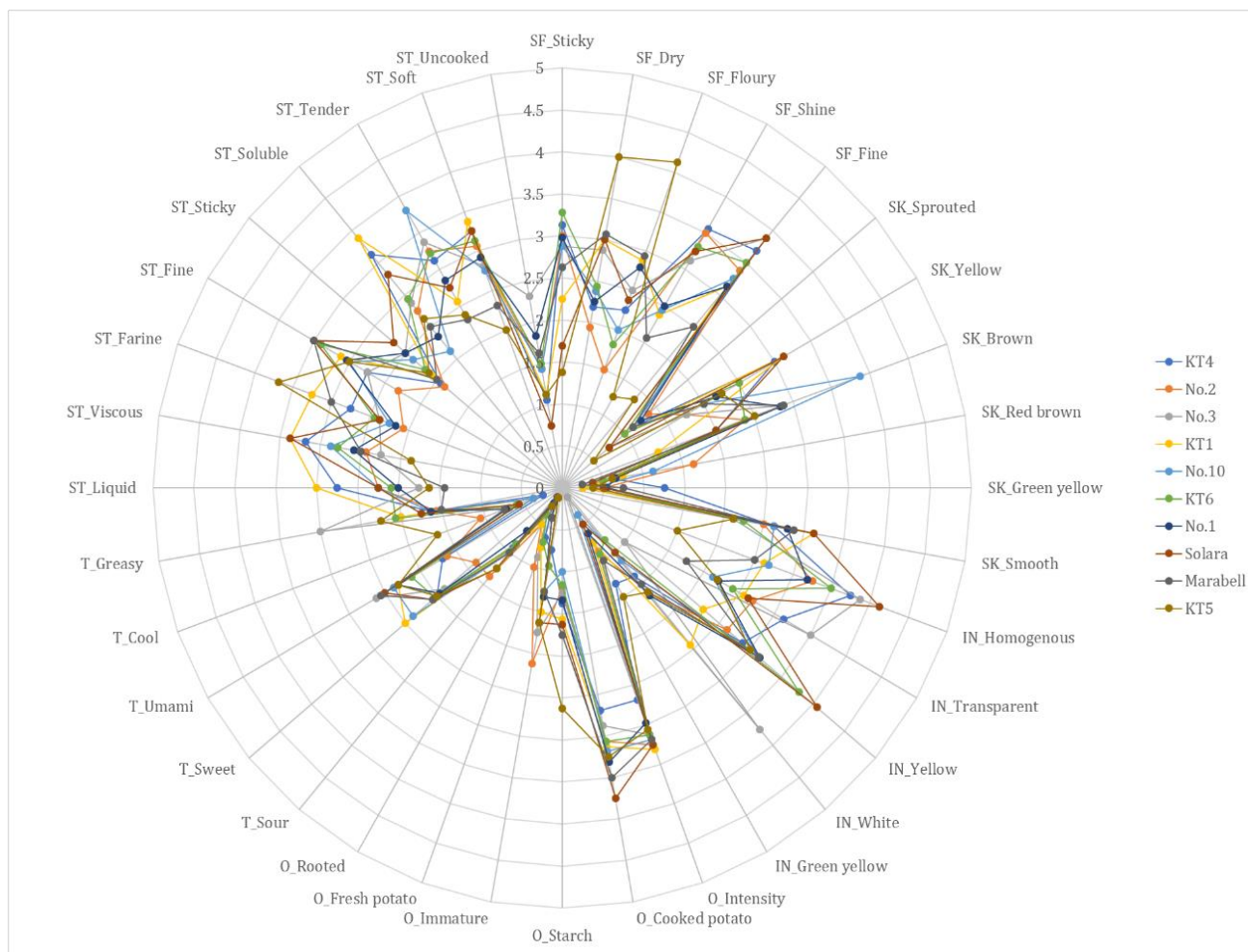
Figure 30. Profile of all 10 potato samples in research

Figure 30 shows the characteristics of all 10 potato samples and we can observe the differences between samples.

3.2.2. Focus group discussion
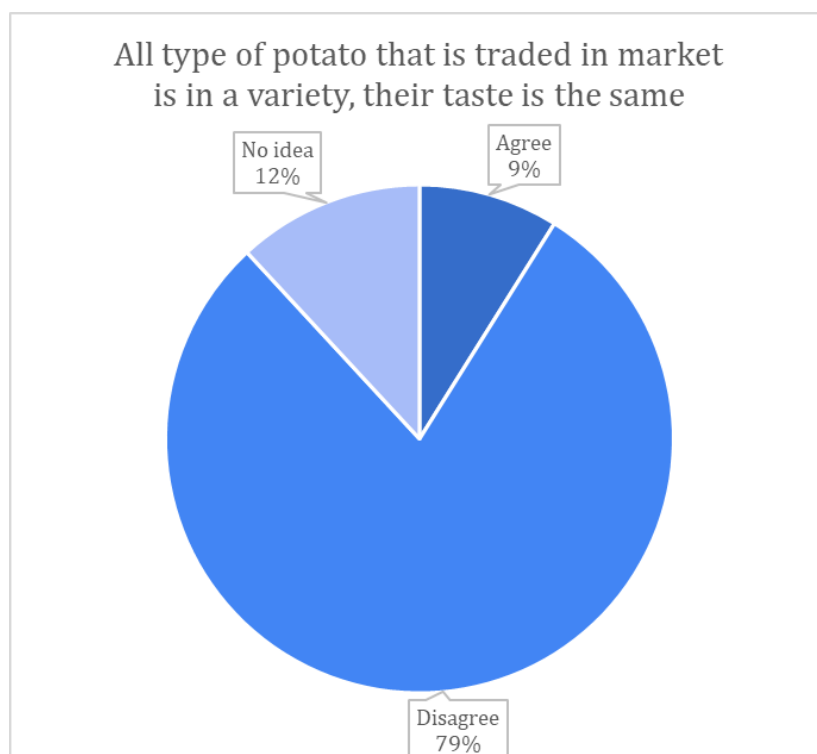
Consumption habits on the potato

Figure 31. Consumers' opinion about statement:" All type of potato that is traded in market is in a variety, their taste is the same"

Table 29. Statement and most chosen opinion of potato consumption habit questionnaire

Statement	Most chosen opinion	Quantity of consumer choose opinion
Cooked potato dishes	Soup	86/101
Favourite shape of potato	Bold	58/101
Favourite flesh colour	Yellow	94/101
Favourite characteristics of cooked potato	Friable	77/101
Position of potato in meal	Main dishes	76/101
Favourite material is cooked with potato	Pork	97/101
Reasons of choosing potato to replace other foods	Meal diversity	82/101
Factors affect to choosing potato	Price	76/101
Acceptable price of potato	10.000-15.000 VND/kg	45/101
Minimum acceptable price	Below 10.000 VND/kg	47/101

Contrastingly with sweetpotato, consumers usually use potato to cook *main dishes*, *soup, or cook with pork* favourite shape is bold instead of oblong (sweetpotato). Potato is consumed with *high diversity*, and can be replacement of other foods. In addition, the most important characteristics when consumer selected potato is colour (both flesh and peel – No green) (3.88 – standard error: 1.05).
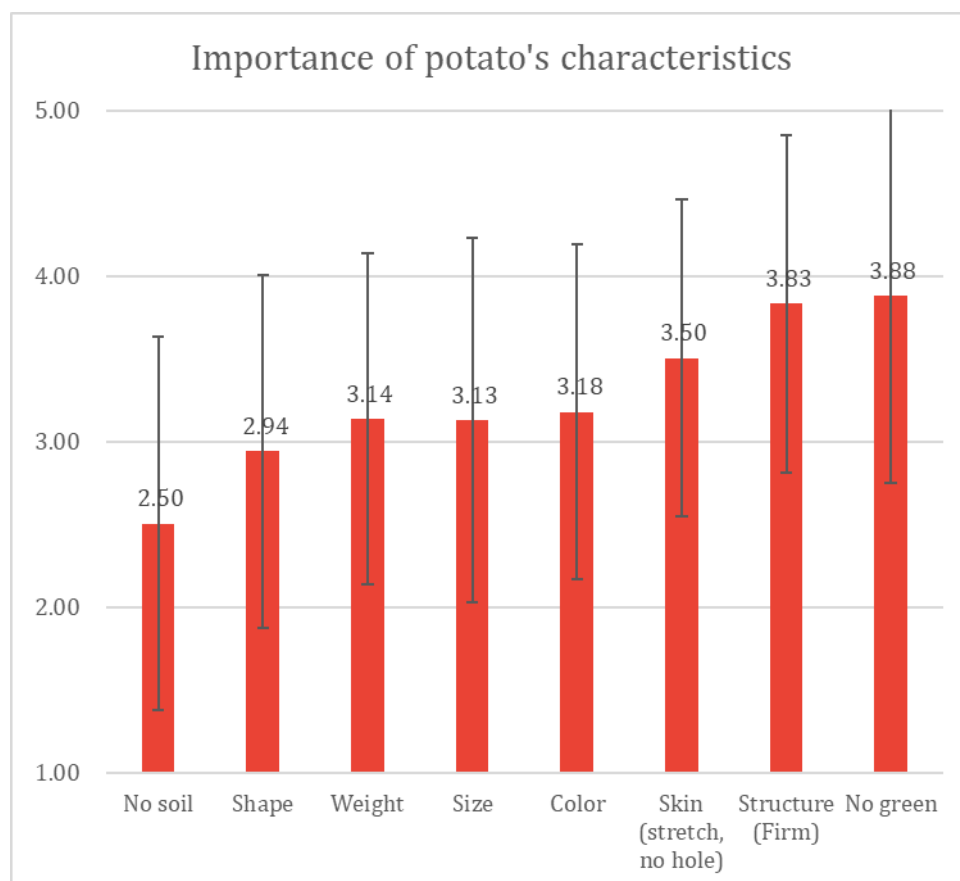
Figure 32. Importance of potato's characteristics and their standard error

*Notes: 1 – Not important: 5 - Very important

In figure 33, the results shown that potato was consumed more frequency than sweetpotato (majority of consumer eat potato more than 2-3 times per week). Potato was more familiar with daily meal than sweetpotato. Consumers can cook potato with many kinds of food (soup, French fry, snack, frying ....)
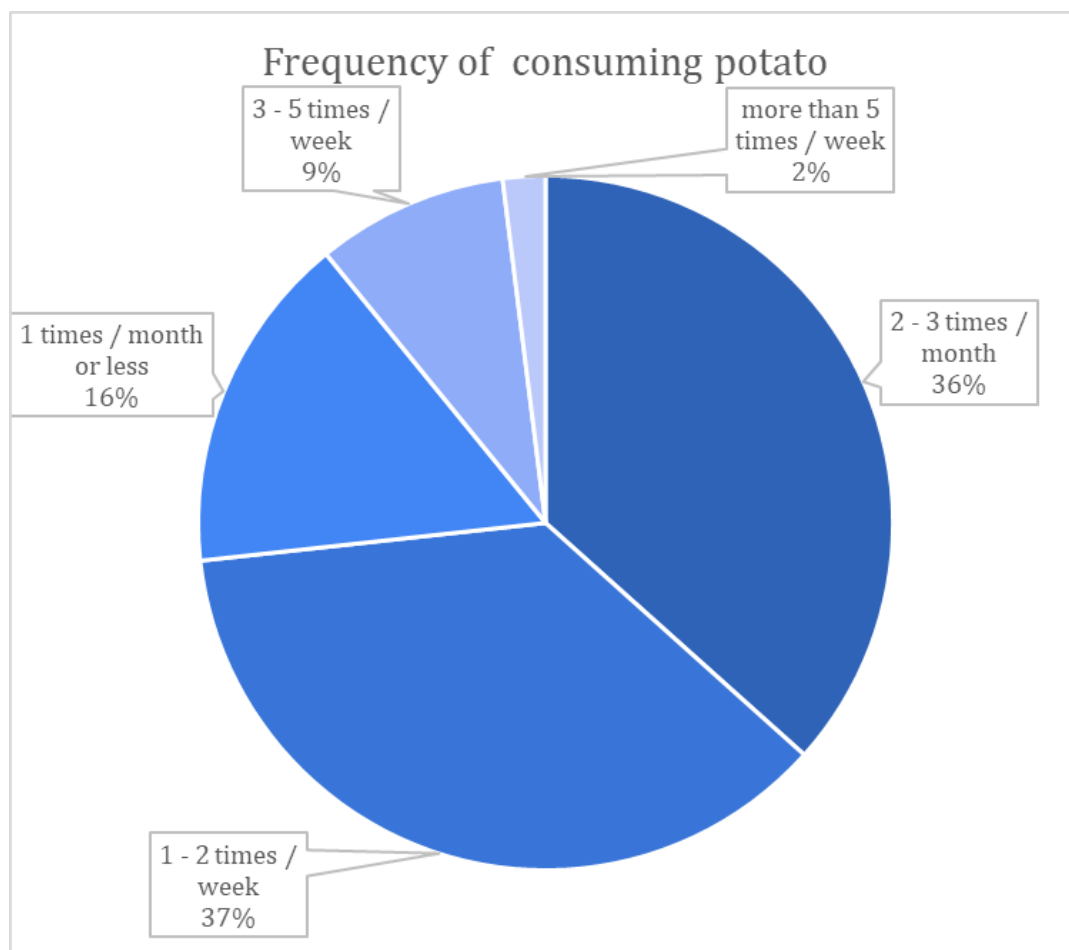
Figure 33. Frequency of consuming potato

Consumer's opinion and preferences on the potato

Table 30. Resume all the opinion on the potato

	Potato
Social representation	- Children's favorite food - Never be fed up because there are many cooking possibilities - Bland taste but very tasty when cooked - Very popular, easy to cook, easy to eat - Cheap/good price Rich nutrition: starch, vitamin C and minerals
Usage and Attitude	- Makes you fat - Good food for cold weather - "Potato is vegetable, replacing vegetable" vs. "Potato is not vegetable, is to replace rice" - French fries, mash potato, stew with bones, sautéed, curry, … many ways to cook Potato! - Rarely eat boiled/steamed potato alone like sweetpotato - Not good when sprouts, the Potato sprout is toxic; the green part doesn't taste good - Often have 1-2kg of fresh potato at home for cooking; There is a way to keep potato for long time

- *Social representation*

For the older consumers, the social representation of potatoes is similar sweetpotatoes, associated with childhood (in/after war). Potato is replacement for rice and several foods is made by potato such as boiled potato with sugar, mashed tomato with tomato sauce and lettuce. Potatoes is classified as a vegetable in both preparation and nutrition of families. When they grow up and get married, potatoes can be bought more easy and more frequent. Potatoes are gradually positioned as an alternative starch source for rice.

During meals, when eating food with potatoes as an ingredient, they often reduce the amount of rice and other starch sources.

Besides, potato representation is expanded, associated with a modern snack for young people such as potato chips with many forms (thin sliced, thick sliced, thinly sliced, etc.), eaten at any time and meal of the day and many consumption places (cinema, drinking, going out ...).

In general, potato is a common, nutritious food and easy to cook.

- *Favourite potato varieties*

Most of the participants in both 2 groups of young people (students, male and female) were not interested in the varieties of potatoes currently on the market, thinking that all varieties of potatoes were all the same.

However, consumers in the high-income group pay attention to the origin of potatoes whether potatoes are domestic varieties or grown in China. But in contrast to sweetpotatoes, consumers can distinguish Chinese potato and domestic potato.

Table 31. The comparison between Chinese potato and Domestic potato

Chinese potato	Domestic potato
Big side	Small side
More yellow than domestic varieties	Less yellow than China varieties
Have red soil on peel (typical soil in China)	Have brown soil on peel.
Pale taste	More delicious than China varieties

Although origin is an important criterion in choosing potatoes, there is a fundamental difference that people in high incomes groups will not choose Chinese potatoes because they do not feel safety when using them, while low-income people will choose if it fits their criteria (eg, need big one to fry, less sprout to peel easier...). However, in general, Vietnamese consumers still favour domestic potatoes over Chinese potatoes.

There is an opinion in the female group that the colour of the outer peel of the potato (yellow) is different due to the different soil that they are grown.

- *Favourite and least preferred characteristics of potato*

Table 32. Favourite characteristics of fresh potato

Characteristics	Male group	Female group
Shape	No sprout	No sprout, not crooked, stretched peel
Size	Average size	Average size
Color of peel?	Not green	Yellow peel (homogenous)
Structure	Firm and not soft	

Table 33. Least preferred characteristics of fresh potato

Characteristics	Male group	Reasons	Female group	Reasons
Size	Small *But in some opinions, size is not important, both big and small are ok.*	Small size is inconvenient, difficult to remove peel or cook.	Small	Not Mealy, difficult to remove peel or cook.
Shape			Crooked shape	Difficult to remove peel
Color	Green	Sign of disease	Green	*Green potato is grown on earth, they will be like un-cooked potato when cook.*
Other	Sprouted	Poisoned	Sprouted, fine peel	Poisoned, inconvenient when remove peel

Table 34. Choosing potato criteria (sorting by importance)

Male group	Female group
Opinion 1: No sprout, no strange thing (hole, green peel)/suitable side	Opinion 1: Color/No sprout/No hole/Stretch peel
Opinion 2: No sprout, no strange thing (hole, green peel)/suitable side	Opinion 2: Color (Not green)/No cut/No sprout
Opinion 3: No sprout, no strange thing (hole, green peel)/suitable side/not be an old potato.	Opinion 3: Color (Not green)/Side (average)/shape (not crooked)
Opinion 4: No sprout, no strange thing (hole, green peel)/suitable side/firm	Opinion 4: Color (Not green)/No sprout
Opinion 5: No sprout/acceptable price	⇨ Color/No sprout/No hole/Stretch peel
⇨ No sprout, no strange thing (hole, green peel)/suitable side	

In cooking, potatoes are also paid attention more than sweetpotatoes. Especially female consumers because there are more risks of toxins and food safety than sweetpotatoes. Sprouted potatoes contain a toxin (solanine) that can be deadly in sufficient doses, which is well known to the vast majority of consumers and is the primary criterion when selecting and preparing potatoes. Also, potatoes with green peel are not good potatoes, so they will often cut the peels deeply to remove the green peel or sprout areas.

Type of food are made by potatoes

Focus group's participants mention several common foods are made by potato such as: fried potato, potato chip, cooked potato, French fries. All participants said that they have not ever eat boiled (steamed) potato.

Table 35. Potato's type of cooking point of view

Male					Female				
Type	User	Popularity	Seller	Properties	Type	User	Popularity	Seller	Properties
French fries	Students, pupils	Easy to buy	Convenient store, Fast food store (KFC, Lotte)	Crispy, soft inside, crispy outside but tough inside, unbroken	French fries	Youth	Easy to buy	Supermarket, fast food store, school food stalls	Crispy, soft inside, flavor additive (cheese)
Wet fry	Everyone	Meal dishes		Mealy	Soup	Everyone	Meal dishes		Mealy, yellow
					Chips	Youth	Easy to buy	Supermarket, convenient store, grocery	Crispy

An opinion in female group: *"Potatoes are sold in few seasons, mostly in winter"*. An additional opinion: *"Potato can be reserved in a long time"*, so potato can be found in all year.

Most of consumers buy potatoes in two main locations: supermarkets and traditional markets. Supermarkets have been chosen less (mainly high-income groups choose this location) due to the price, but have the advantage of having more types or varieties of potato than traditional markets. Participants mention two other places, which are rarely chosen, are e-commerce (or online-shopping) platform and wholesale markets. Participants rarely choose e-commerce platform because they will not see products with the own eyes, this makes them choose product more difficulty. In addition, the wholesale market is too far from accommodation, this make them be in-convenient for travel.

In point of view of consumers, potatoes are easy to buy and cheap (15,000-20,000 VND/kg). However, only female consumers pay attention to price of potatoes because they are often associated with housework, while men hardly know or pay attention about the price of potatoes. If they have to go buy potatoes, they usually just choose potatoes based on number and size of potatoes. They usually do not deal with seller and let the seller determine the price. Because potatoes are cheap and easy to buy, consumers no longer have the habit of preserve potatoes and only buy when they need it (1-2 times per week), 1-2kg/time and choose smooth potatoes, less sprouts for convenience during preparation.

- *Boiled potato cooking procedure*

No participants have boiled potato for cooking. Some participants only parboil potato for preparation (to remove peel when mashing potato)

- *Favourite and dislike characteristics of boiled potato*

Most people like potatoes cooked with pig bones, pork, beef (soup)

Table 36. Favorite characteristics of boiled potatoes (Soup type)

Male		Female	
Favourite characteristics	Testing procedure	Favourite characteristics	Testing procedure
Soft	Eating and evaluate structure in mouth	Mealy, delicious and good flavour	Eating and evaluate characteristics in mouth

Table 37. Less desirable characteristics of boiled potatoes (Soup type)

Male		Female	
Less desirable characteristics	Testing procedure	Less desirable characteristics	Testing procedure
Un-cooked, not homogeneous	Eating and evaluate structure in mouth	Not Mealy, un-cooked, pale colour	Eating or using spoon to mash potato, checking flesh potato

A participant in female group said that she likes potatoes are yellow after cooking.

- *Potato in daily life*

Table 38. Reasons for consuming boiled potatoes (Soup type)

Male			Female		
Reason	Frequency	Importance of potato in diet	Reason	Frequency	Importance of potato in diet
Changes dishes, substitute for vegetable, cooking with pork bone	Usually	Can cook with a lot of materials	Material of hot pot, in new year party	Rarely, only in new year holiday	Not importance

A participant in young female group do not eat potato too much because preparing and cooking potato is time consuming. In young male group, a consumer said that: *"When I see a pot of boiled bone, I will think about potato".* In addition, the other participant classify potato as a starch source, can replace rice in meal (will reduce rice in consuming if eat potato before).

"The simmered and stewed food will contain potato" – the other focus group member comment.

Besides, the other opinion: *"French fries and potato chips are the most delicious food made by potato"*

- *Improving potato and new potato product ideas*

Most of the male and female participants are satisfied with the current potato varieties quality, no improving idea.

There is an opinion (female group) said that potatoes should increase the firmness and sweetness.

Regarding the idea of new potato-based products, some opinions from the female group suggested the following products: Potato shrimp noodles, mashed potatoes for salad, mixed with mayonnaise, rolls with potatoes, potatoes mixed with cheese.

3.2.3. Consumer test

Liking score for potato products

Liking data are analysed by Analysis of Variant (ANOVA) – Single factor. Liking data include 4 type of liking score: General liking, Appearance liking, Odour liking and Structure liking. As results of ANOVA, all products' average liking score are in acceptable range ($>4/7$) and the difference between liking scores is significant ($p\text{-value}<0.0001$).
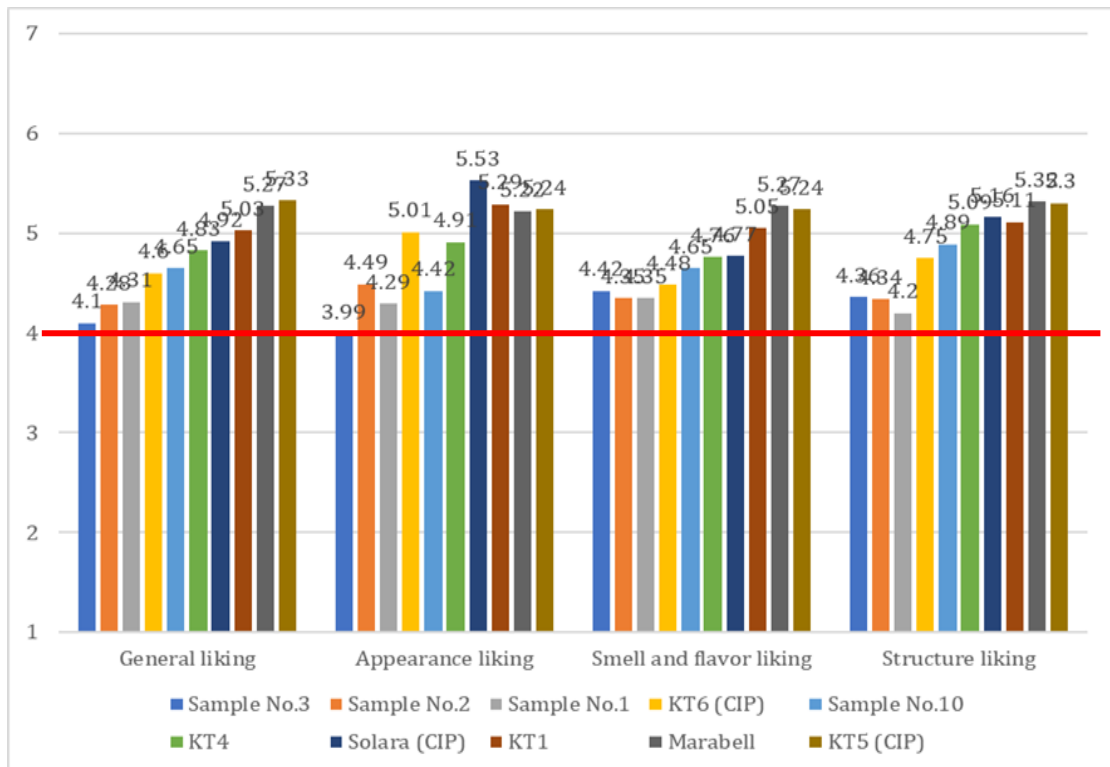
Figure 34. Average hedonic score of 10 potato samples
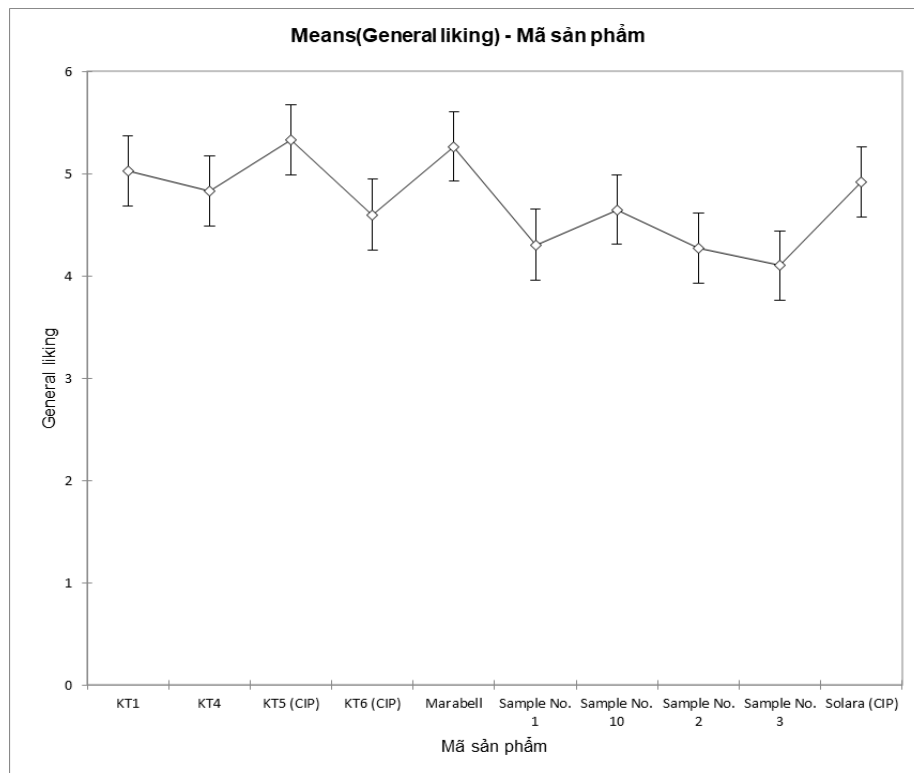
Figure 35. Means of the six potato products' general liking

KT5 had the highest overall liking score, followed by 3 samples: Marabell, KT1, Solara (CIP). However, according to Fisher's standard, meanliking score of all 3 samples have common means of liking score that was not different from KT5 significantly. With Appearance, Odour and Structure liking, these 4 samples (KT5, Marabell, KT1, Solara) still have the highest points of average liking score, but Solara had the highest points of appearance liking score, Marabell had the highest points of Odour liking and structure liking score. On the other hand, the appearance liking score of sample 3 was in the dislike area, although it was not clear (3.99 points).

Relationship between liking scores/preference patterns with gender and socioeconomic background of consumers (age, education...).

The Hierarchical cluster analysis (HCA) enables division of participants into three groups of similar preference patterns (figure 36).
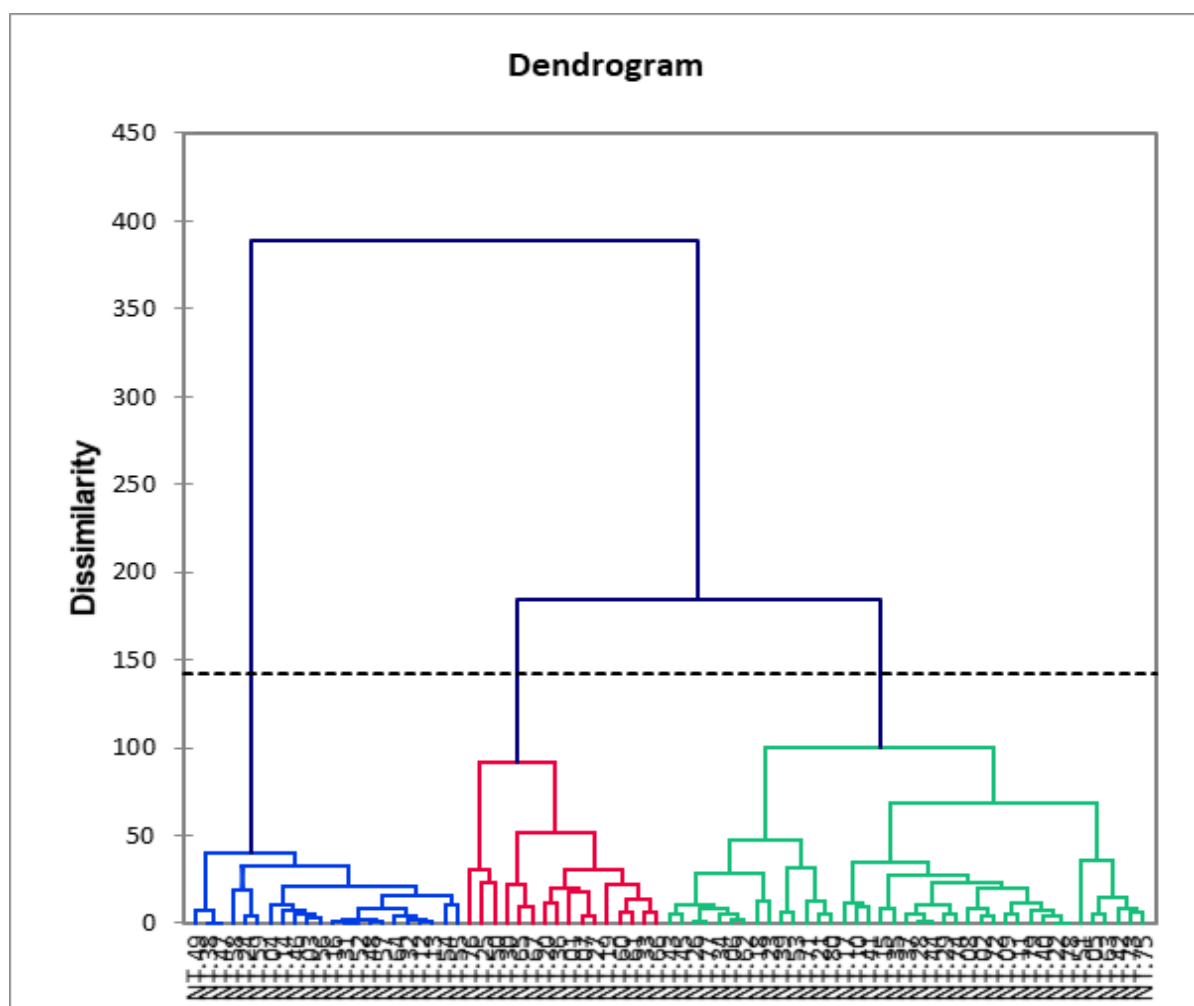
Figure 36. HCA results of three consumer segmentations

Table 39. Preference patterns of three consumer groups

Group	No.3	No.2	Solara (CIP)	No.10	KT6 (CIP)	Marabell	KT5 (CIP)	KT4	KT1	No.1
1	3.625	2.625	3.250	3.000	3.813	4.688	4.438	3.563	3.438	2.644
2	3.615	4.238	5.000	4.692	4.195	5.077	5.137	4.892	5.078	4.213
3	5.409	5.545	6.000	5.909	5.872	6.000	6.318	5.536	6.091	5.682

There are differences between group 1 and group 3 because group 1 preferred all 10 samples while group 3 disliked them. Besides, group 2 dislike sample No.3. This group like others sample but not too much (almost in 4-5 point).

To know better each group, table 40 showed in detail characteristics of each consumer group.

Table 40. Characteristics of each consumer group

		Group 1	Group 2	Group 3
Age	18-23	37.50%	58.97%	22.73%
	24-30	12.50%	0%	4.55%
	31-40	18.75%	7.69%	13.64%
	>40	31.25%	33.33%	59.09%
Gender	Male	6.25%	10.26%	31.82%
	Female	93.75%	89.74%	68.18%
Incomes (VND)	<3m	37.50%	64.10%	40.91%
	3-5m	25.00%	17.95%	31.82%
	5-10m	0%	2.56%	9.09%
	10-15m	31.25%	12.82%	9.09%
	15-30m	0%	2.56%	9.09%
	>30m	6.25%	0%	0%

		Group 1	Group 2	Group 3
Marriage situation	Single	56.25%	58.97%	22.73%
	Married and has children	37.50%	35.90%	77.27%
	Married and has not children yet	6.25%	0%	0%
	Other	0%	5.13%	0%

- *Preference mapping*
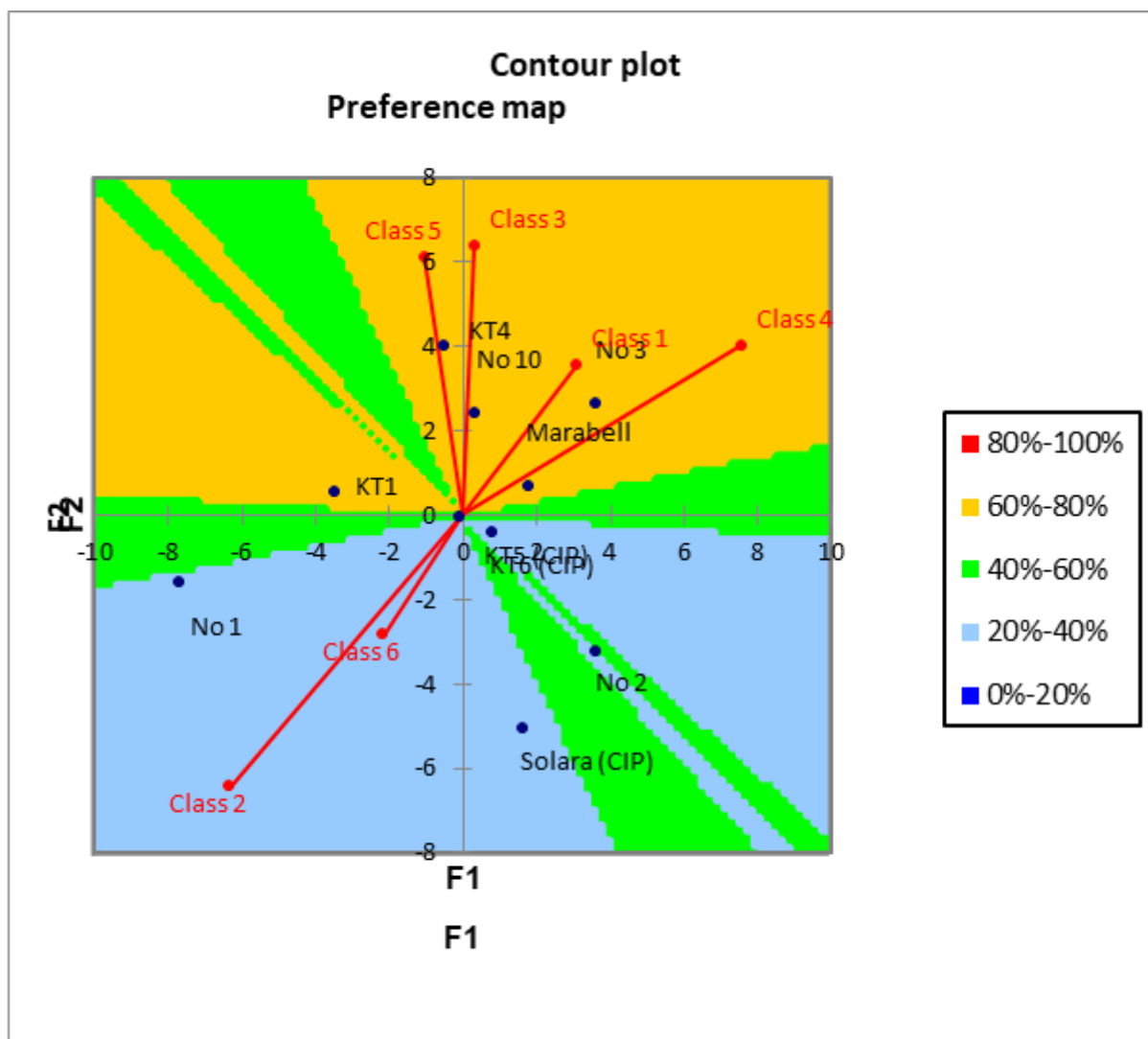
Figure 37. External preference mapping of 6 consumer clusters and potato samples

JAR scale results

The results of JAR analysis on each product allow to orient the modification of the product according to the perception of consumers. Penalty Analysis is applied to CATA data, based on the relationship between the intensity of attributes given on the JAR scale and the hedonic score of products. The difference in the JAR score is only significant when it reduces the overall taste score significantly.
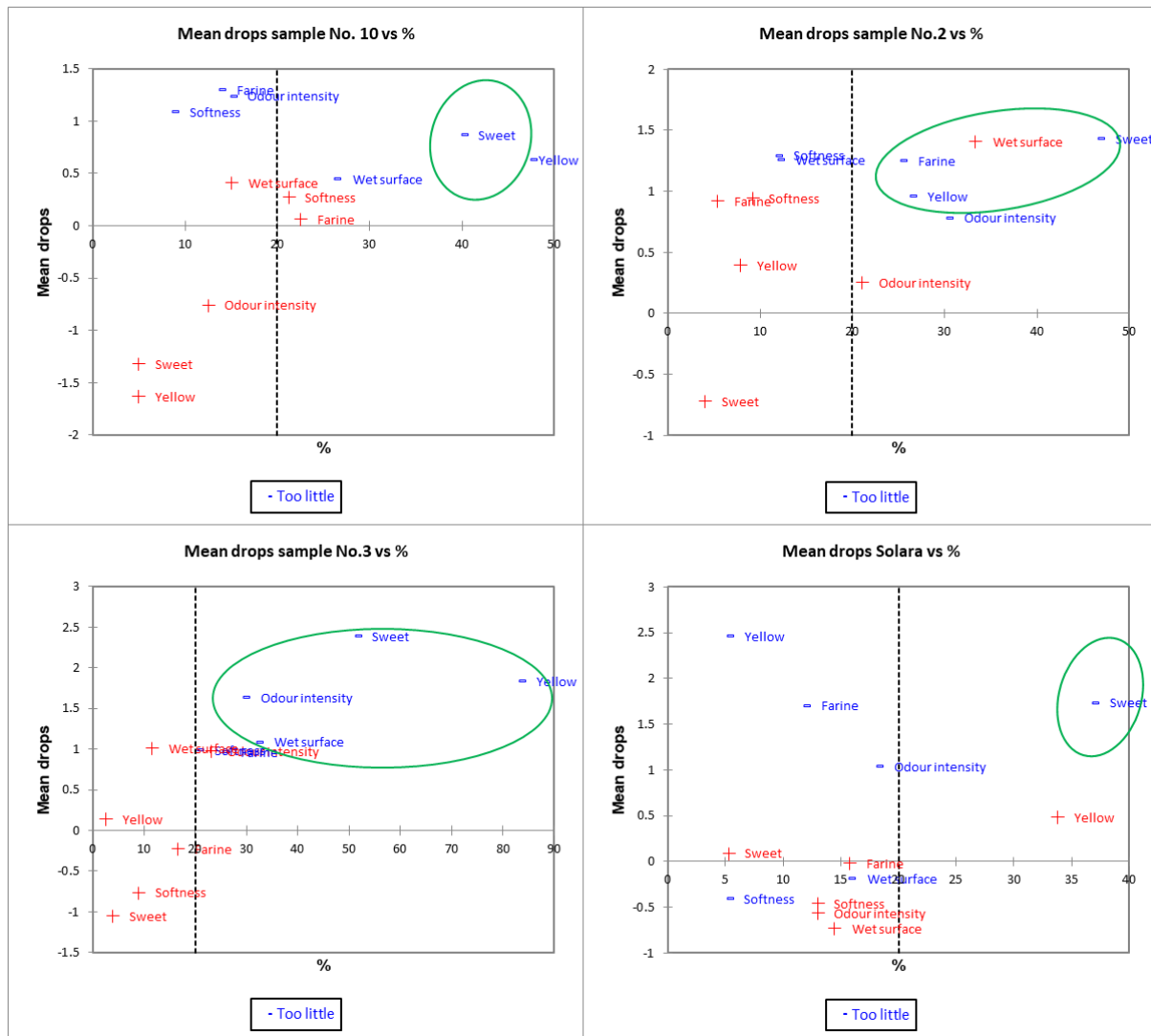
Figure 38. Meandrop map of potato samples (a)

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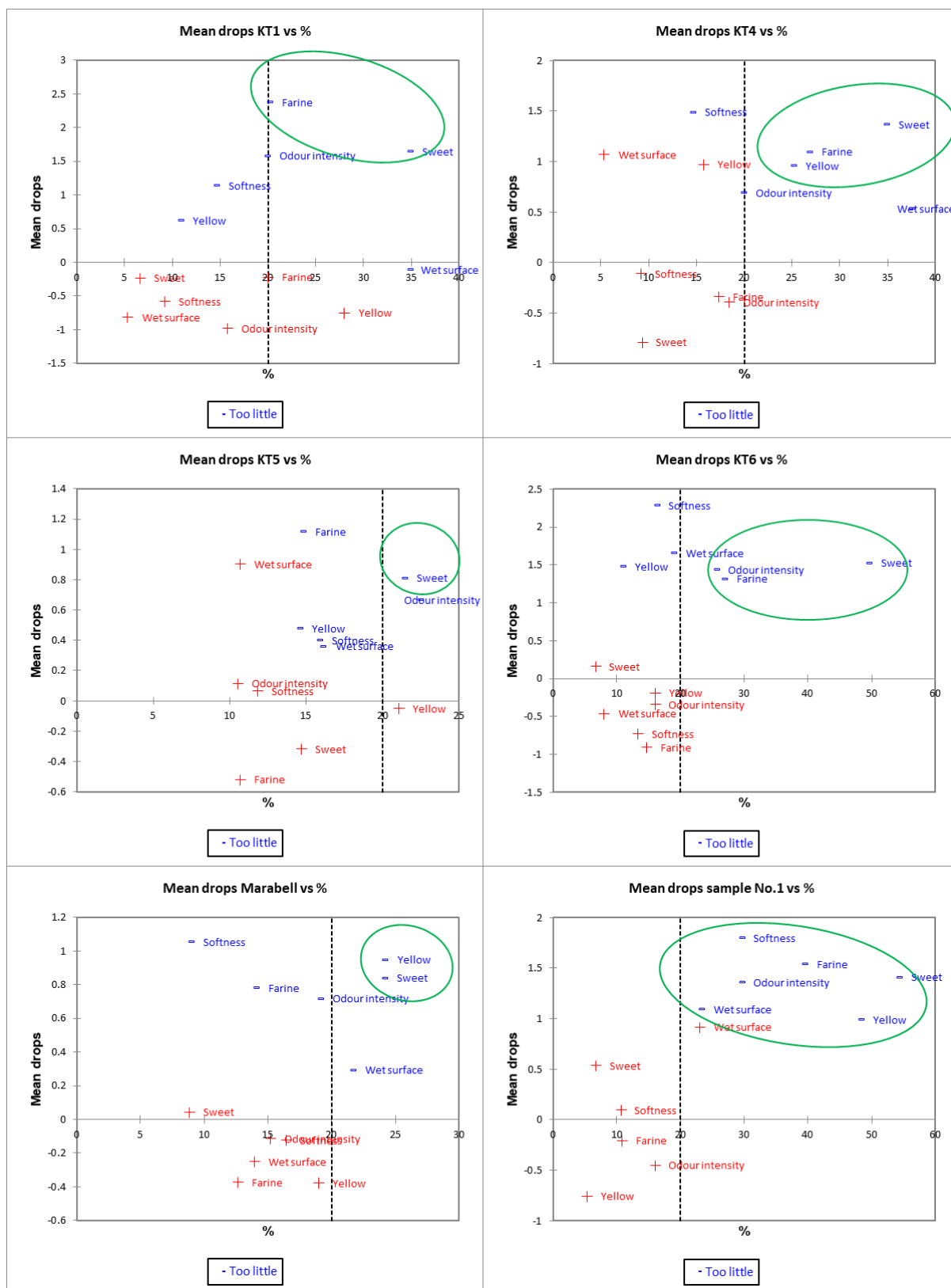
Figure 39. Meandrop map of potato samples (b)

Table 41. Penalties analysis results of potato samples

Samples	Attributes	Mean Drop (=Mean JAR – Mean non-JAR)	p-value	Significant
KT1	Mealy (Less)	2.378 (=5.444-3.067)	< 0.0001	Yes
KT1	Sweet (Less)	1.645 (=5.568-3.923)	< 0.0001	Yes
KT4	Yellow (Less)	0.959 (=5.222-4.263)	0.020	Yes
KT4	Mealy (Less)	1.098 (=5.048-3.950)	0.003	Yes
KT4	Sweet (Less)	1.368 (=5.214-3.846)	< 0.0001	Yes
KT5	Sweet (Less)	0.813 (=5.500-4.688)	0.020	Yes
KT6 (CIP)	Smell intensity (Less)	1.435 (=4.909-3.474)	0.001	Yes
KT6 (CIP)	Mealy (Less)	1.318 (=4.818-3.5)	0.004	Yes
KT6 (CIP)	Sweet (Less)	1.526 (=5.364-3.838)	< 0.0001	Yes
Marabell	Yellow (Less)	0.949 (=5.422-4.474)	0.008	Yes
Marabell	Sweet (Less)	0.840 (=5.472-4.632)	0.011	Yes
No.1	Yellow (Less)	0.993 (=4.743-3.750)	0.006	Yes
No.1	Smell intensity (Less)	1.361 (=4.634-3.273)	0.001	Yes
No.1	Soft (Less)	1.799 (=4.844-3.045)	< 0.0001	Yes
No.1	Wet (Less)	1.094 (=4.8-3.706)	0.037	Yes
No.1	Mealy (Less)	1.54 (=4.919-3.379)	< 0.0001	Yes
No.1	Sweet (Less)	1.413 (=5.138-3.725)	0.000	Yes
No.10	Sweet (Less)	0.869 (=4.932-4.063)	0.007	Yes
No.2	Yellow (Less)	0.96 (=4.56-3.6)	0.018	Yes
No.2	Wet (Much)	1.407 (=4.927-3.520)	0.000	Yes
No.2	Mealy (Less)	1.252 (=4.673-3.421)	0.001	Yes
No.2	Sweet (Less)	1.432 (=4.946-3.514)	< 0.0001	Yes
No.3	Yellow (Less)	1.836 (=5.636-3.8)	0.001	Yes
No.3	Smell intensity (Less)	1.637 (=4.811-3.174)	0.001	Yes
No.3	Wet (Less)	1.088 (=4.568-3.48)	0.011	Yes
No.3	Sweet (Less)	2.386 (=5.286-2.9)	< 0.0001	Yes
Solara CIP	Sweet (Less)	1.734 (=5.591-3.857)	< 0.0001	Yes

No. 1 is the most modified sample, all attributes are less than the consumer's expectations, and reduce the overall liking score significantly. This is the same with No.2 and No.3. Two samples that satisfy consumers and require the least change are Solara and Marabell. Details of the meandrops and penalties of the samples are in the figure below.
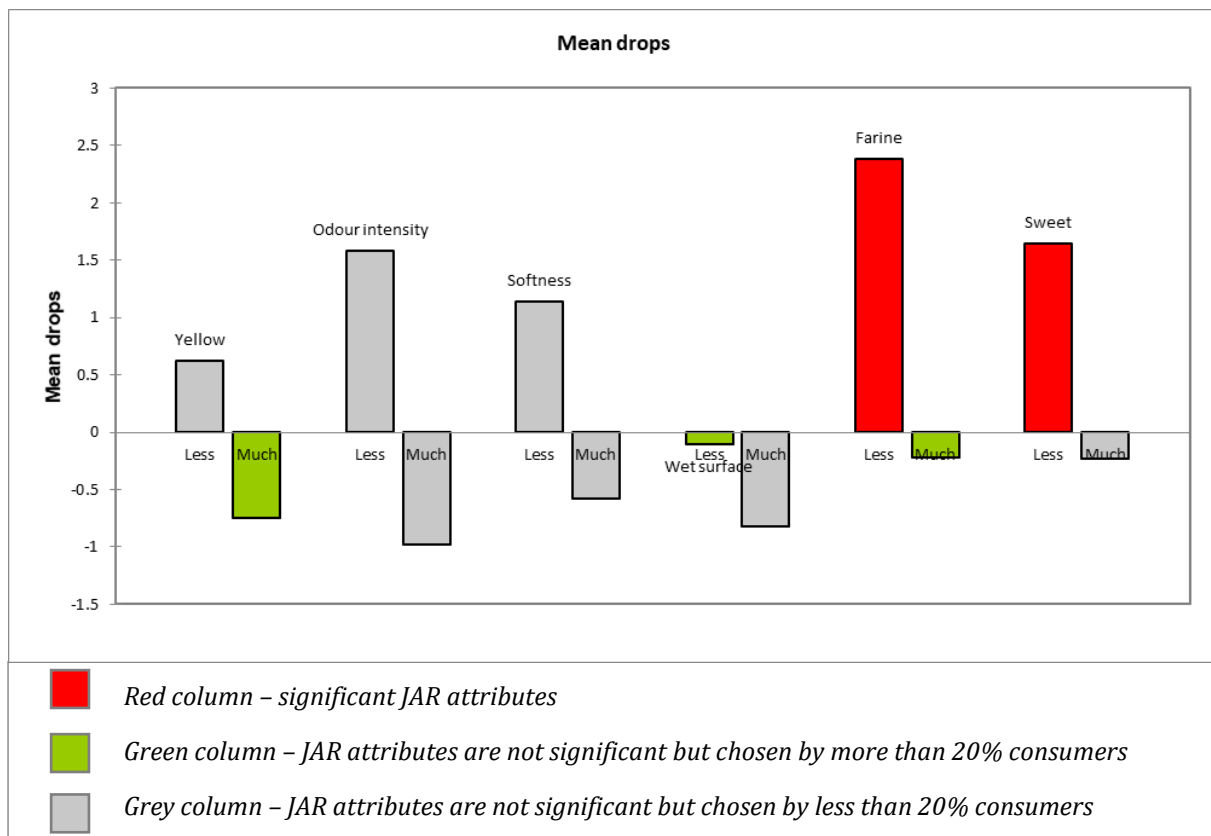
Figure 40. Meandrops of KT1
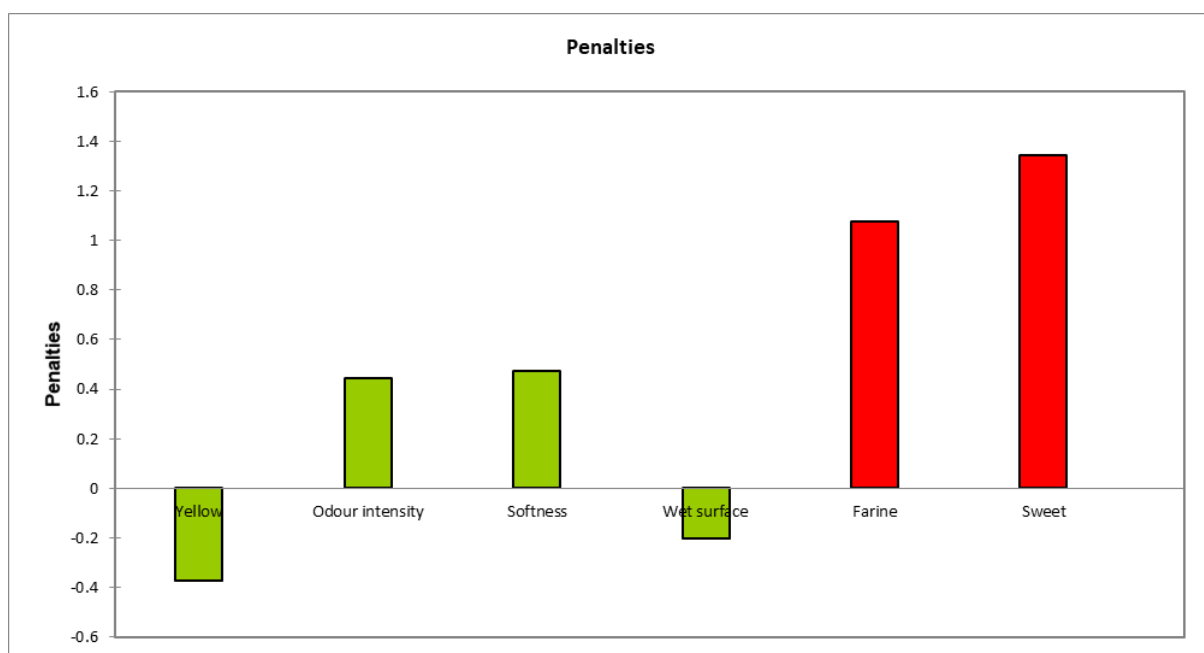
Figure 41. Penalties of KT1
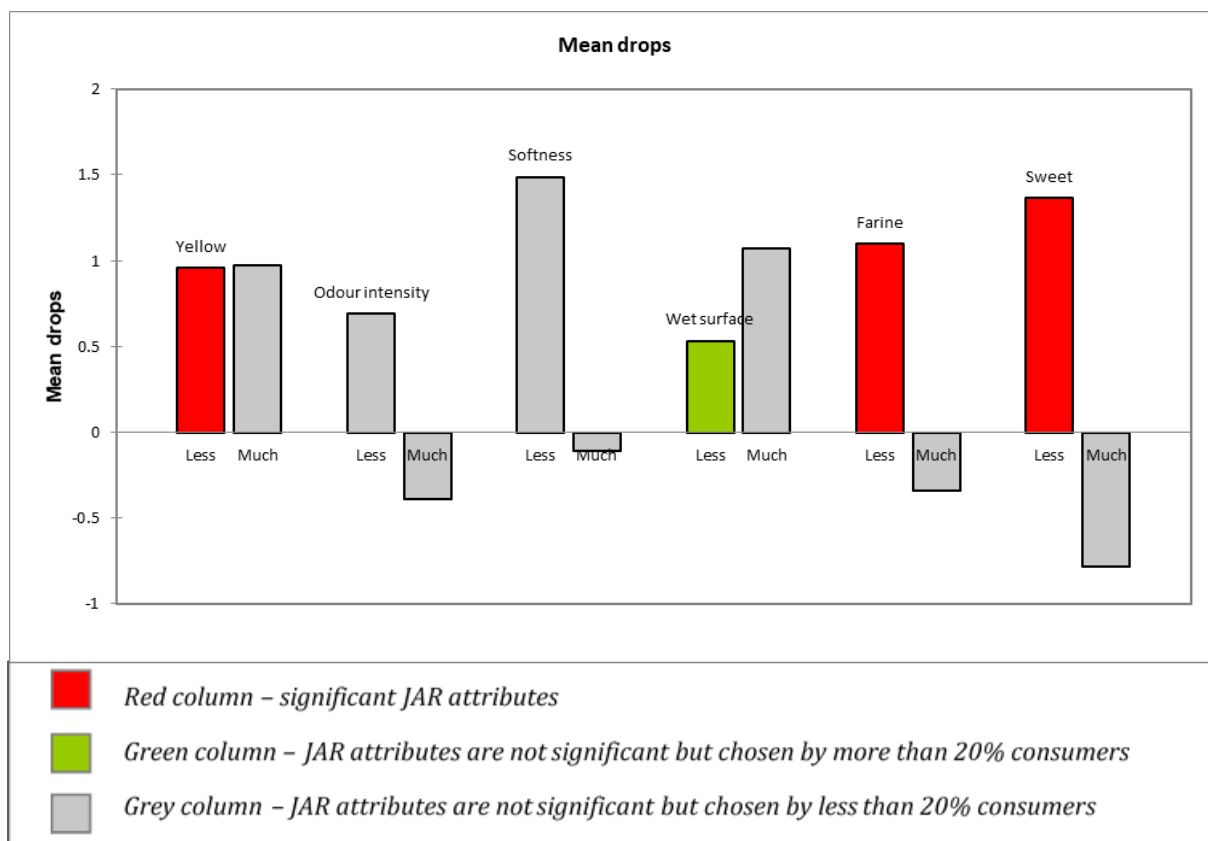
Figure 42. Meandrops of KT4
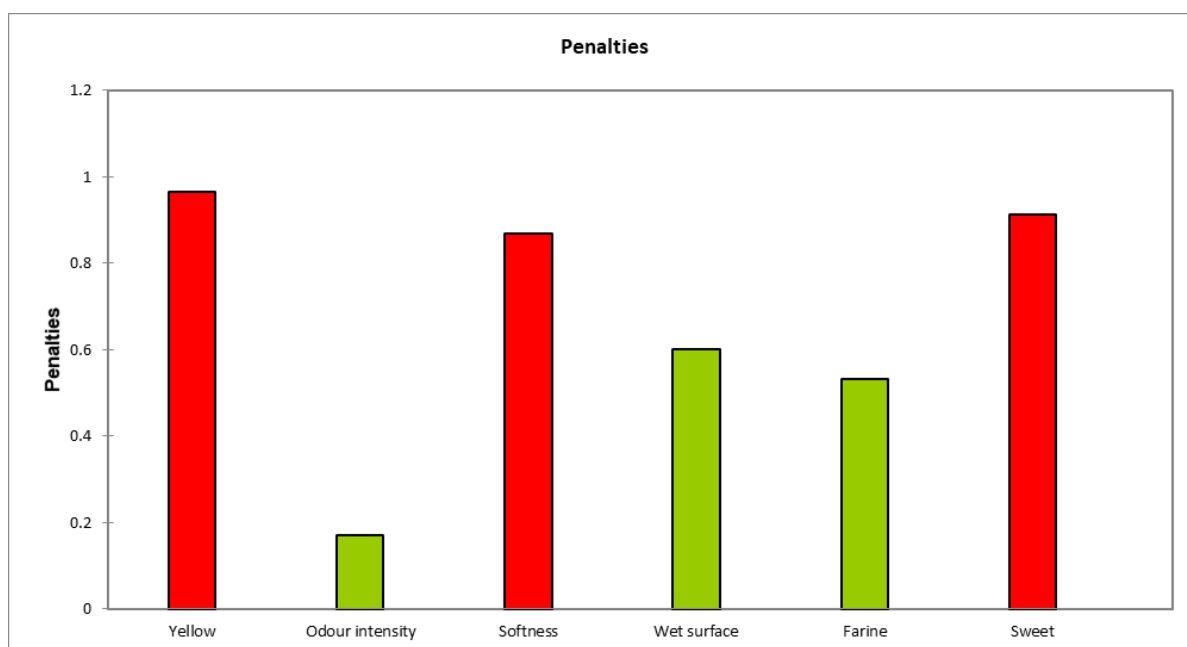
Figure 43. Penalties of KT4
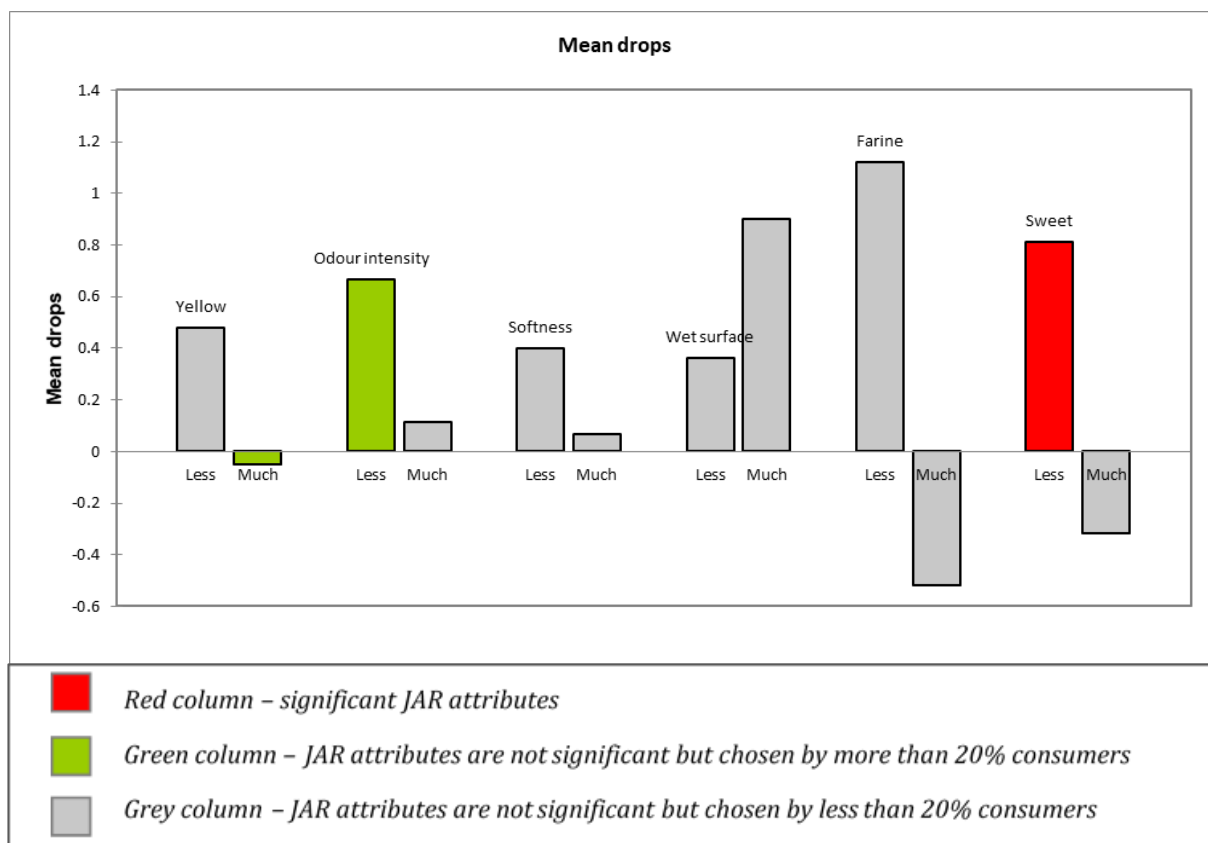
Figure 44. Meandrops of KT5
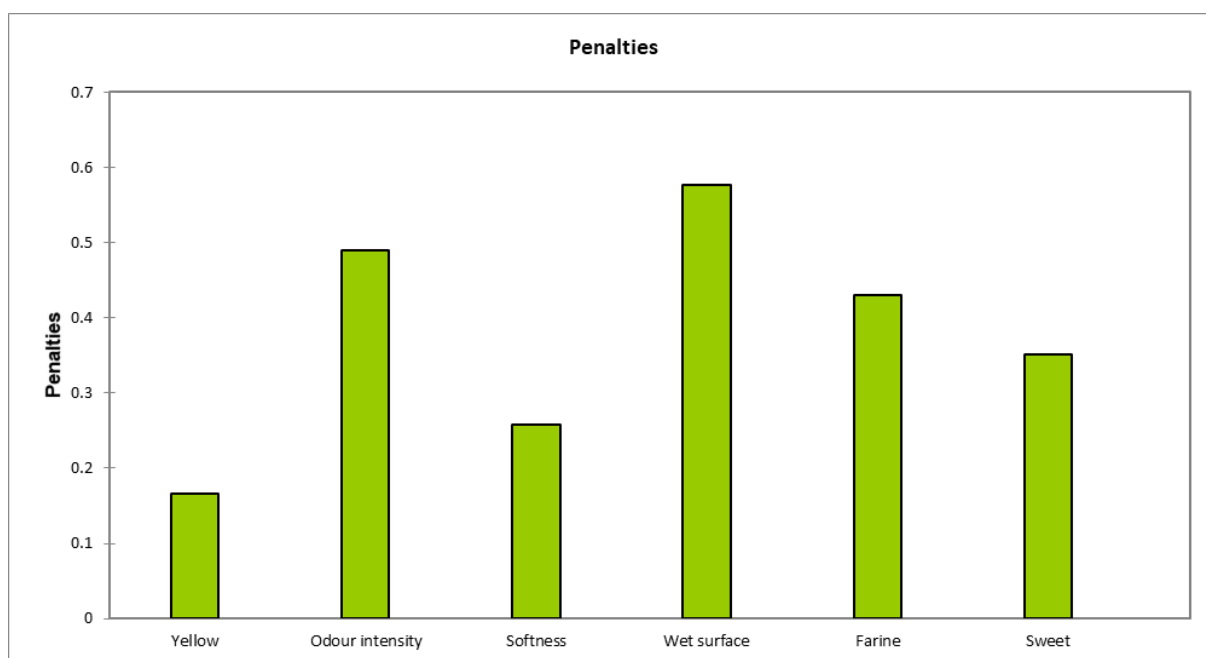
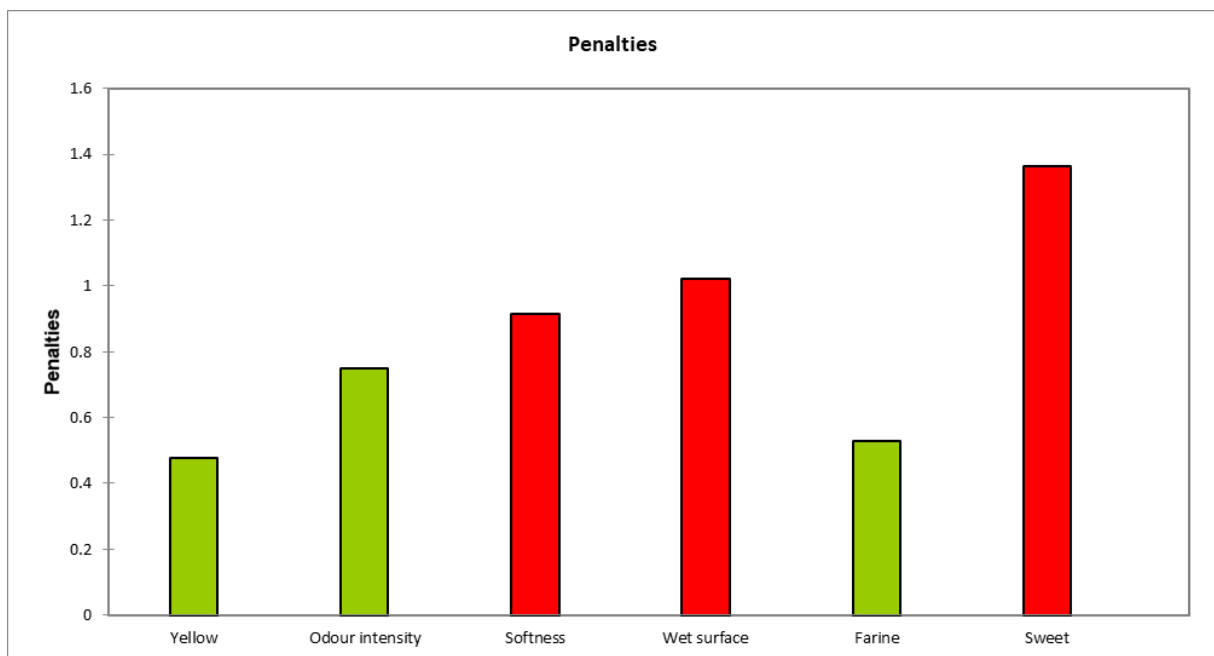Figure 45. Penalties of KT5
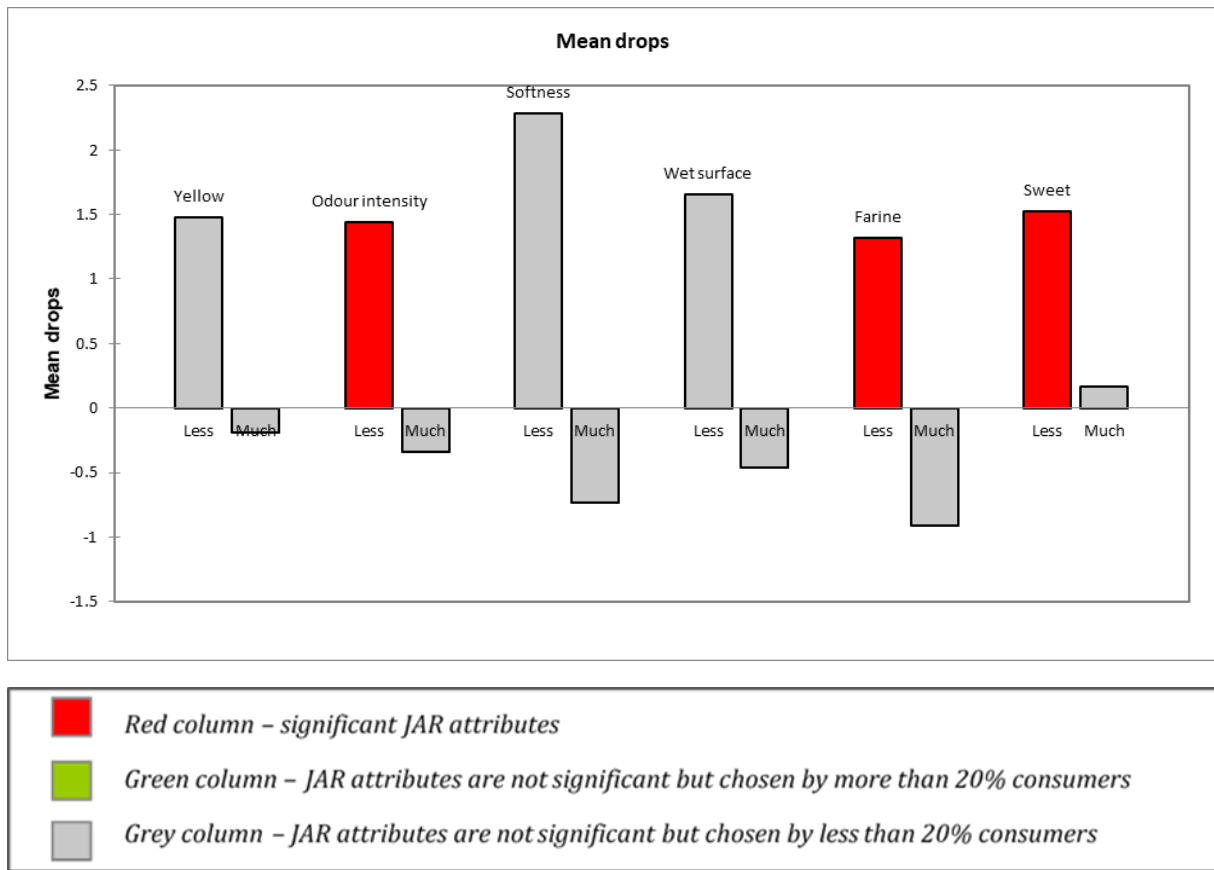
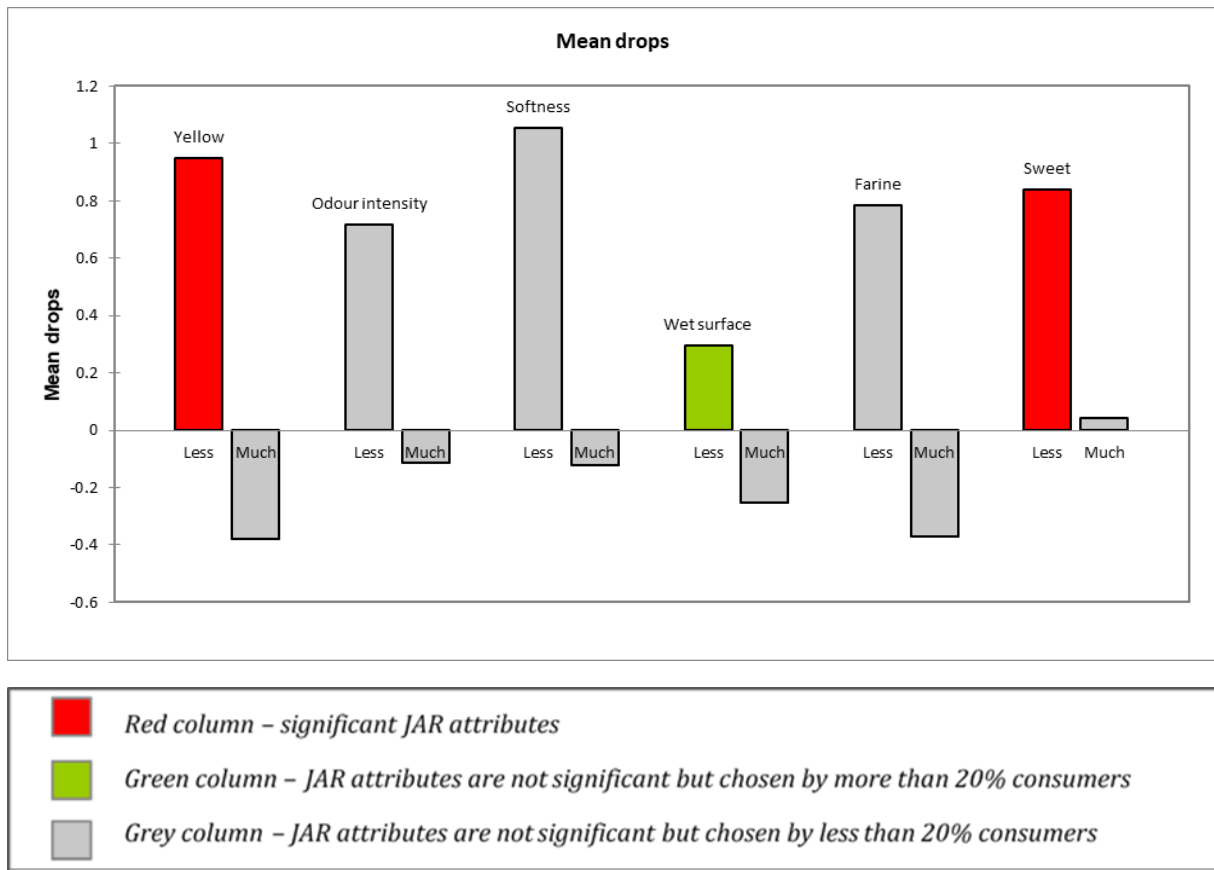Figure 46. Meandrops of KT6

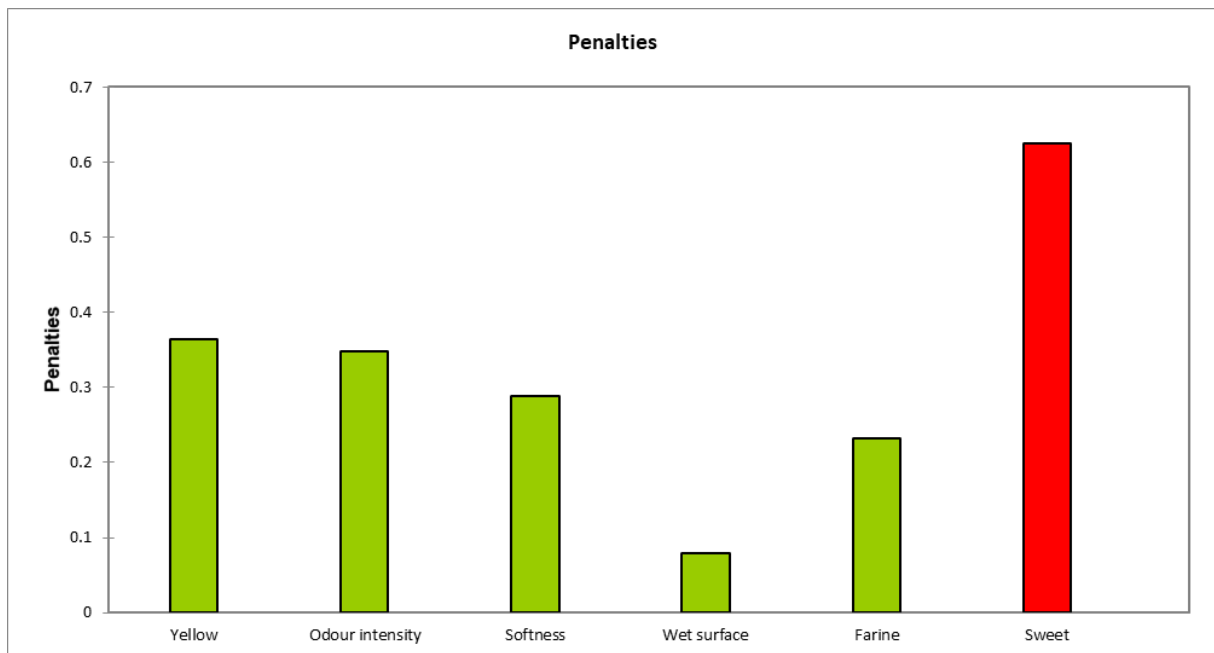Figure 47. Penalties of KT6

Figure 48. Meandrops of Marabell

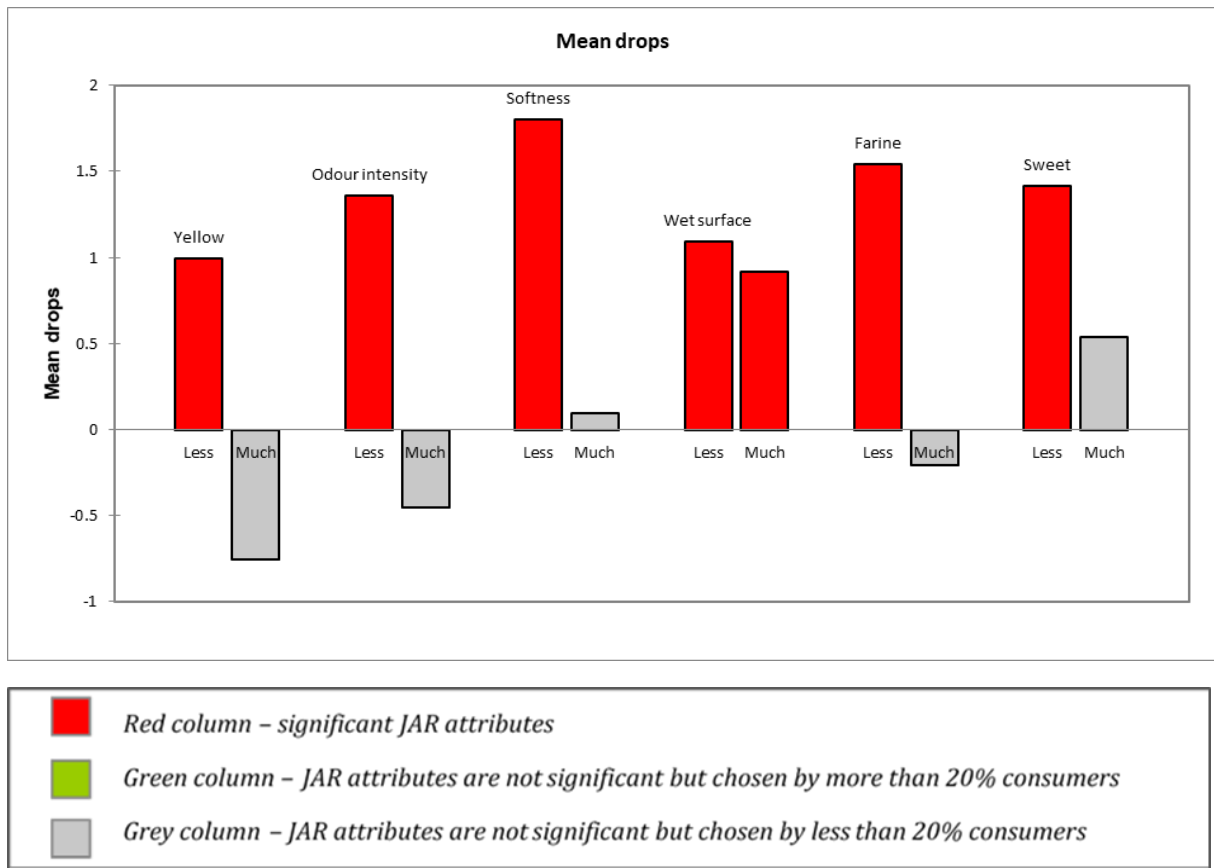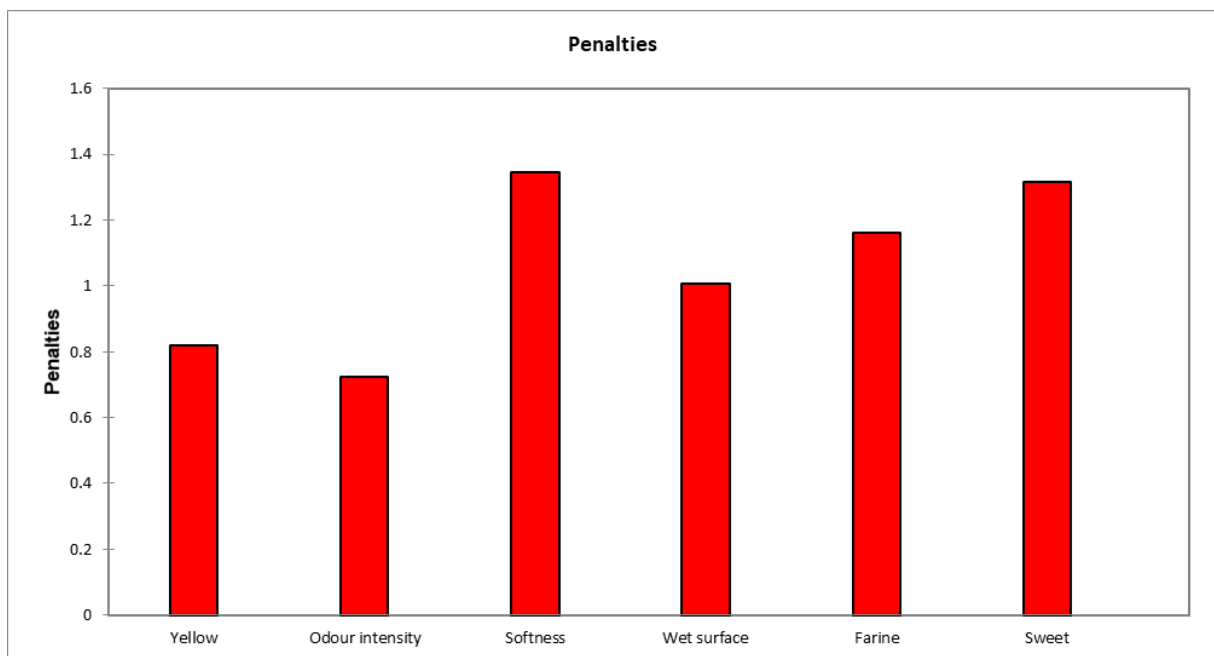Figure 49. Penalties of Marabell

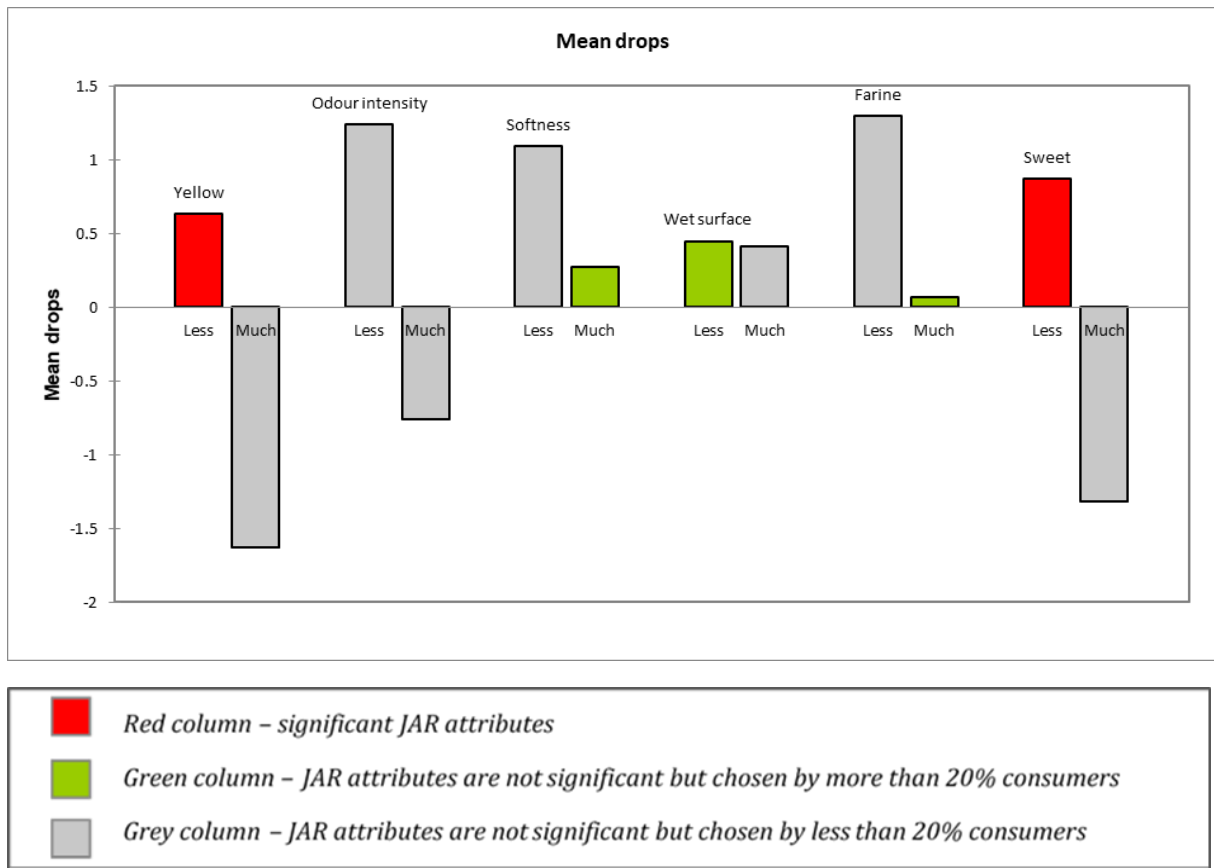Figure 50. Meandrops of No.1

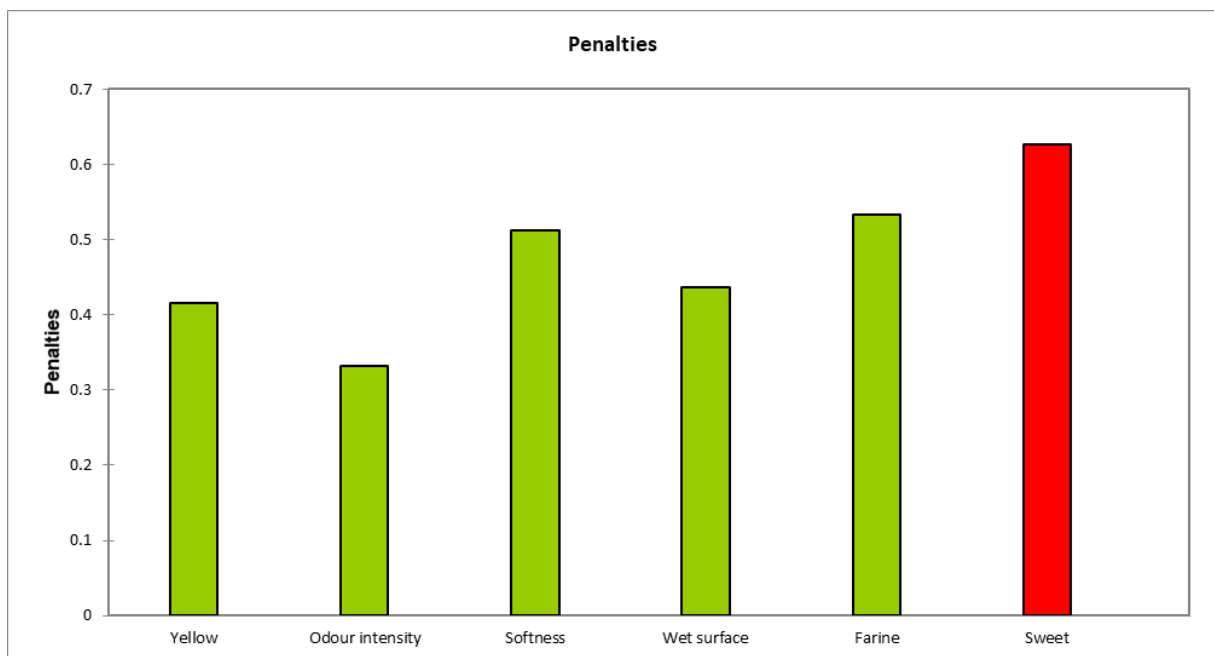Figure 51. Penalties of No.1

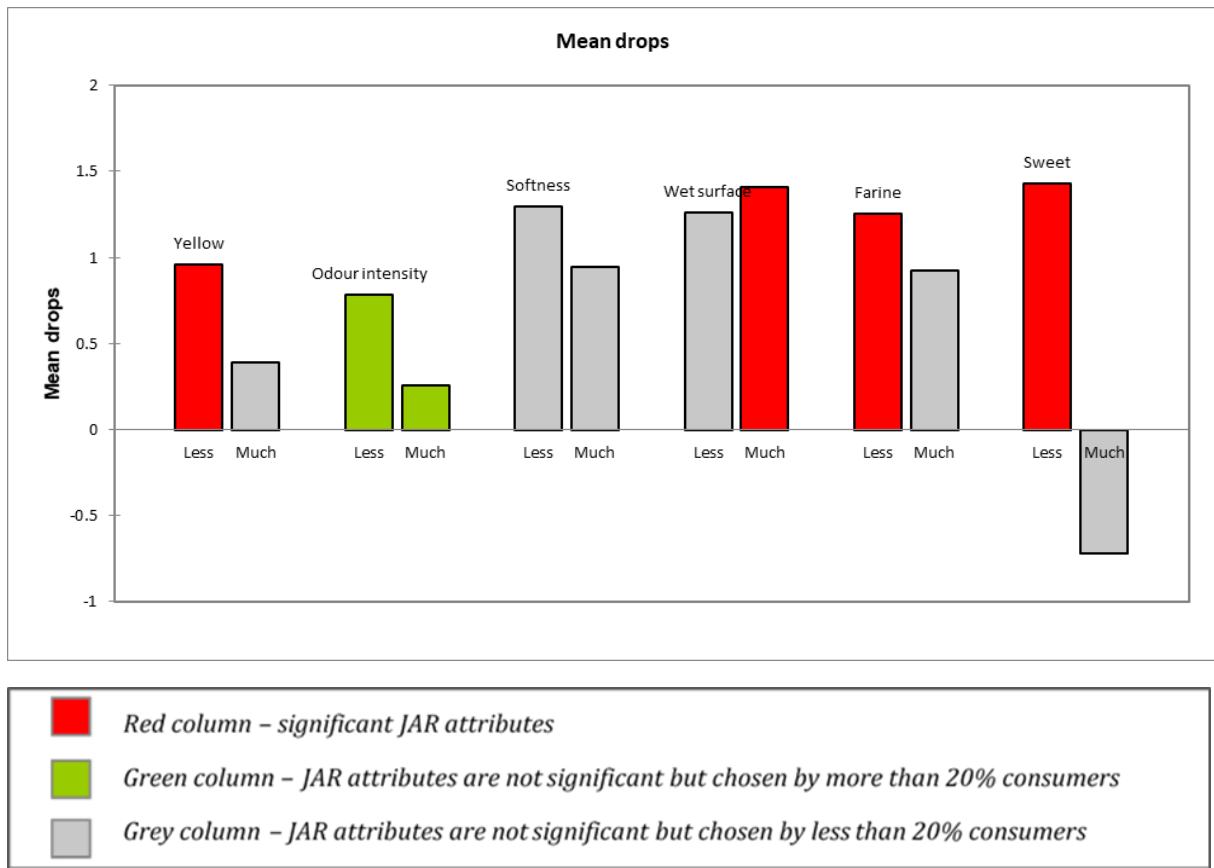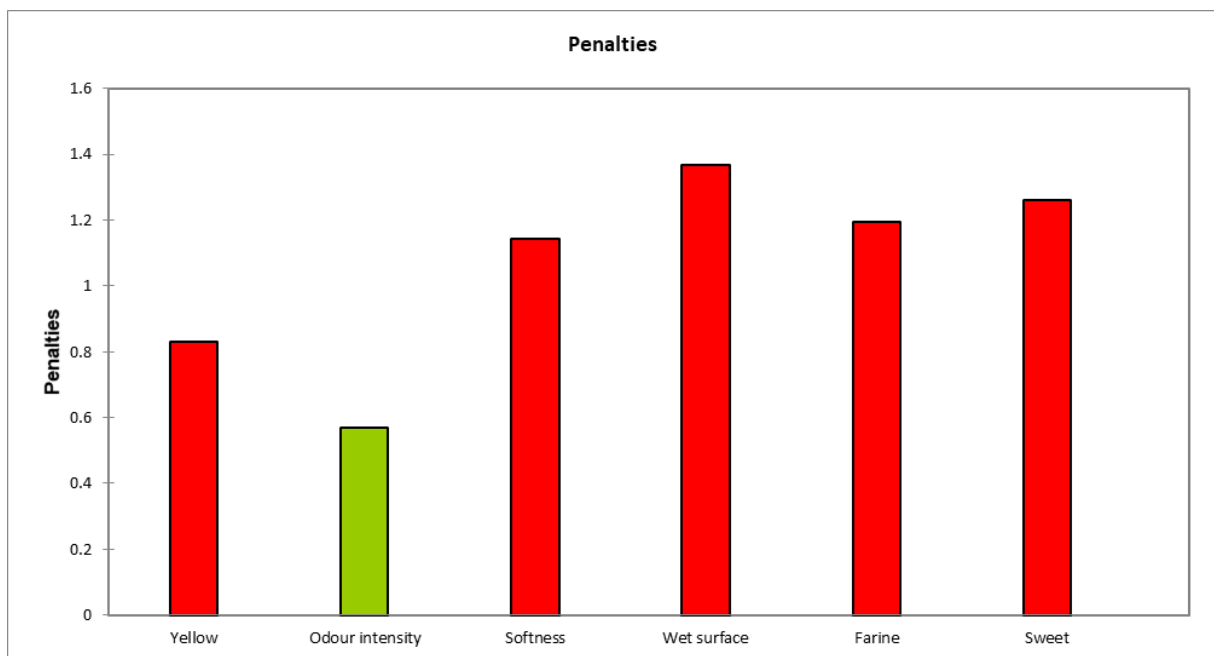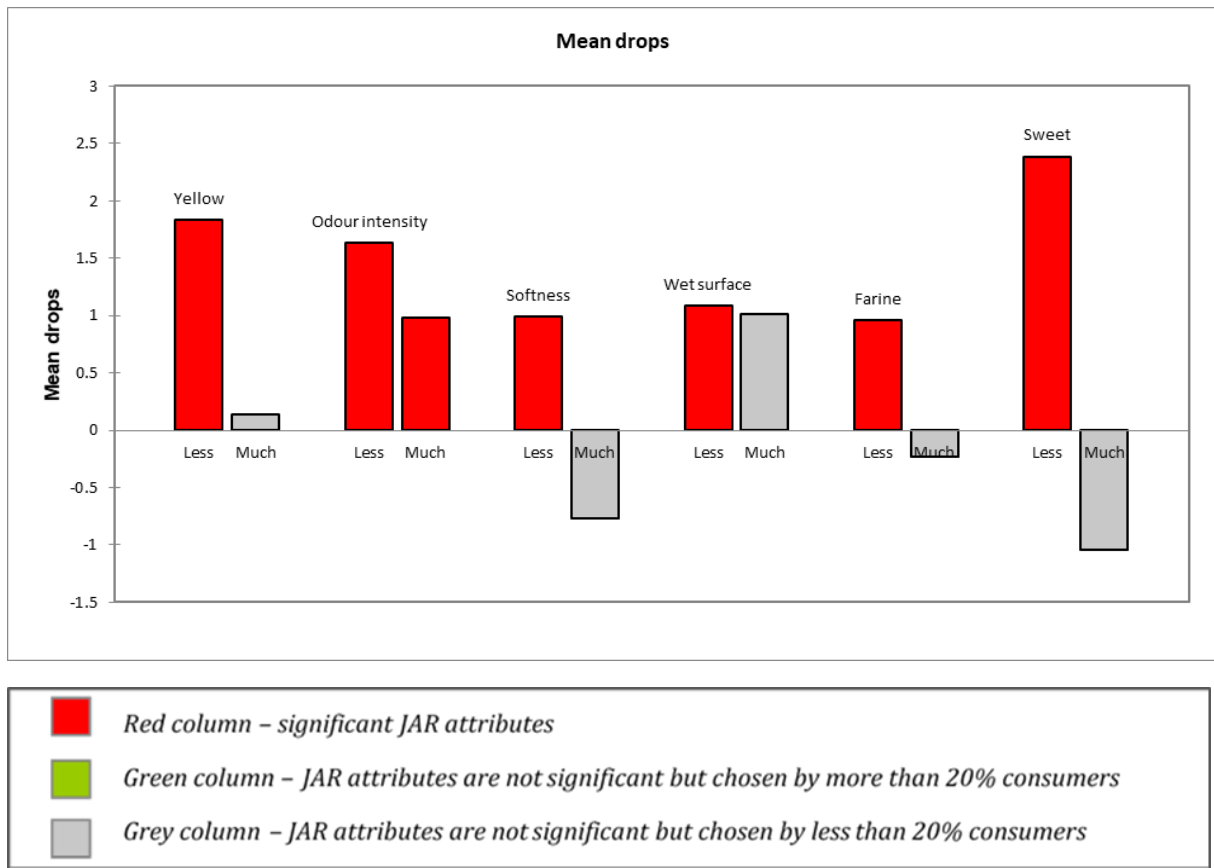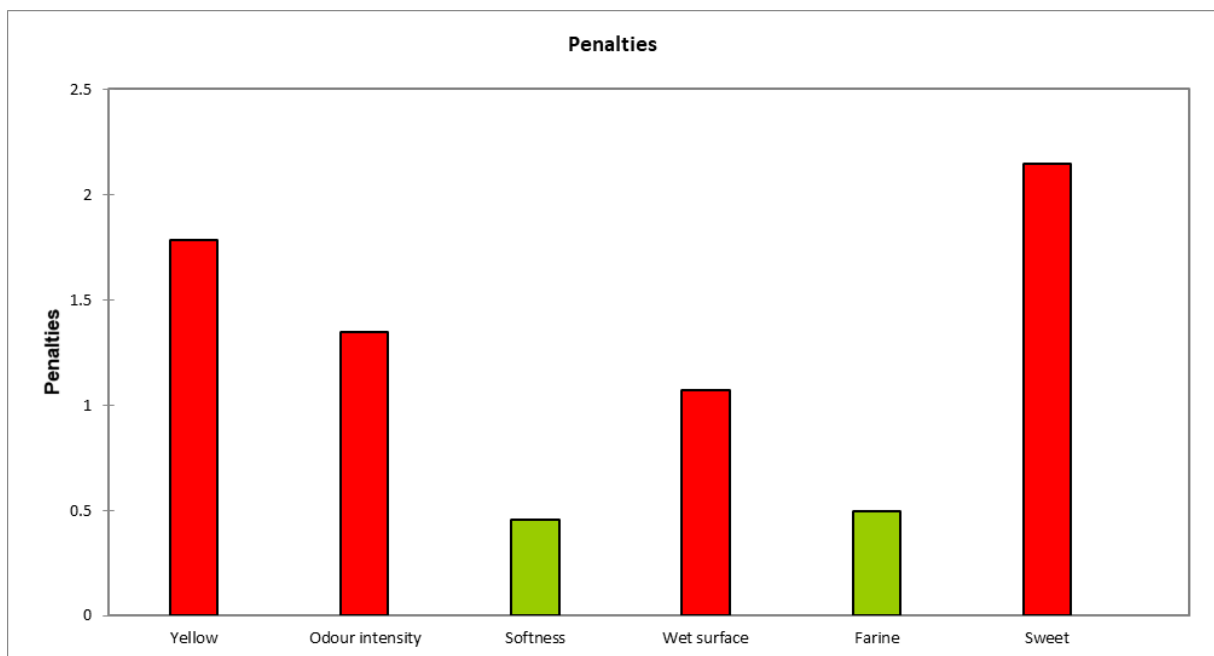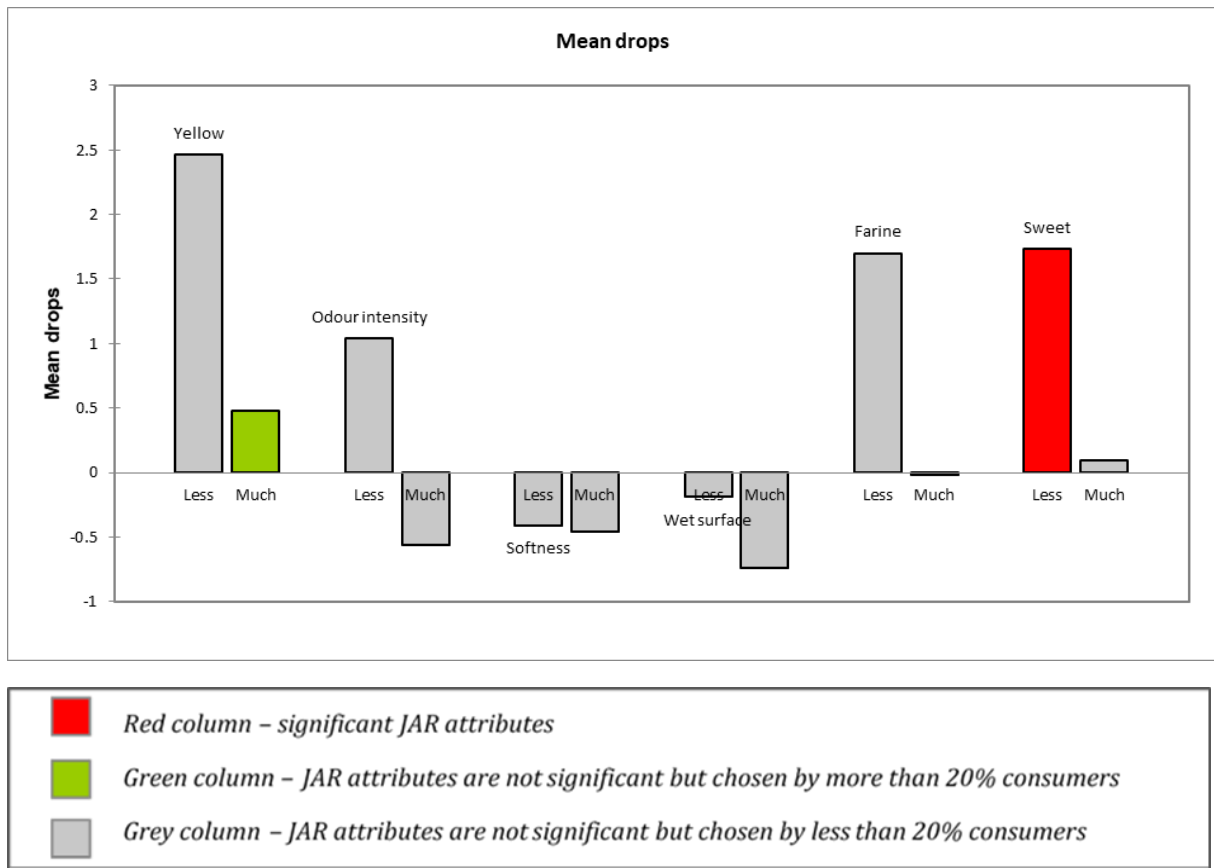Figure 52. Meandrops of No.10

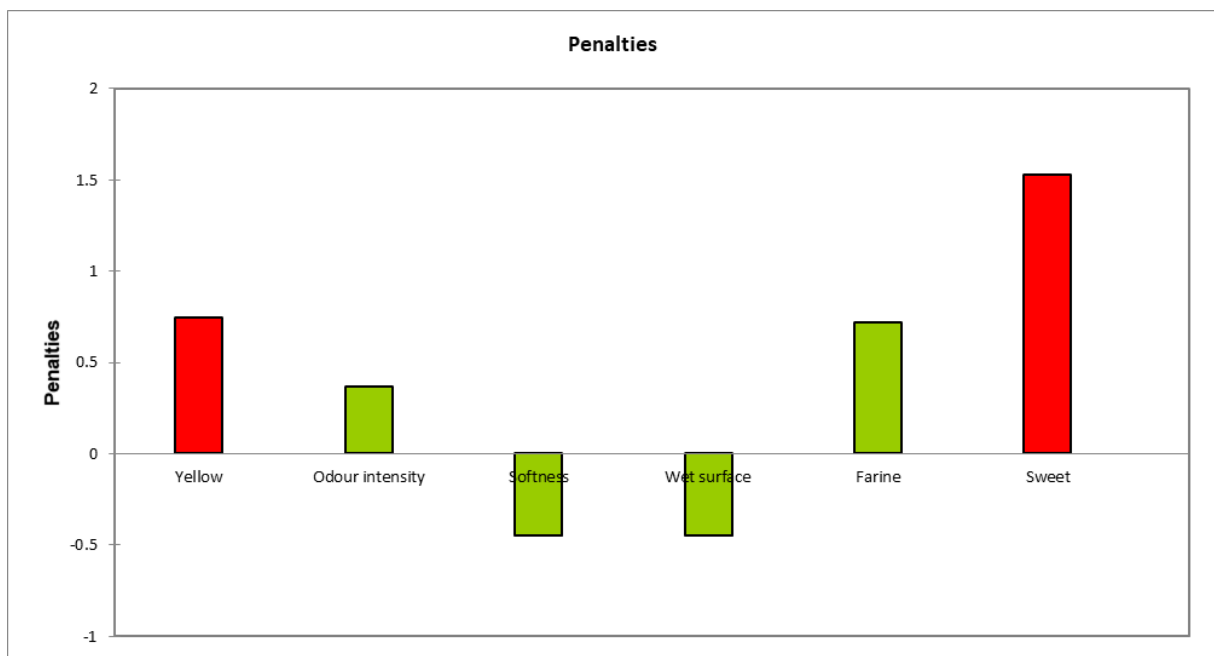

Figure 53. Penalties of No.10

Figure 54. Meandrops of No.2

Figure 55. Penalties of No.2

Figure 56. Meandrops of No.3

Figure 57. Penalties of No.3

Figure 58. Meandrops of Solara

Figure 59. Penalties of Solara

CATA results

Similarly, with sweetpotatoes, a ccorrespondence analysis is applied to CATA data to "connect" attributes that consumers perceive when tasting potato sample. The result is a 2D map, where the red points are presented for attributes, green points are presented for research products.

We can see 3 main groups based on the results of CATA analysis.

- Group 1: No.1, No.3 and No.10. They are characterized by *IN_White, Acrid, Dislike, Tasteless, Discomfort*
- Group 2: No. 2 and KT6 (CIP). They are *smelly, mushy, pasty, and wet.*
- Group 3: KT1, KT4, Marabell, KT5 (CIP), Solara (CIP). They are specifics in *fragrant, delicious, sweetpotato, powdery, easy to eat, natural, honey, even, sweet, eye-catching, yellow inside.*
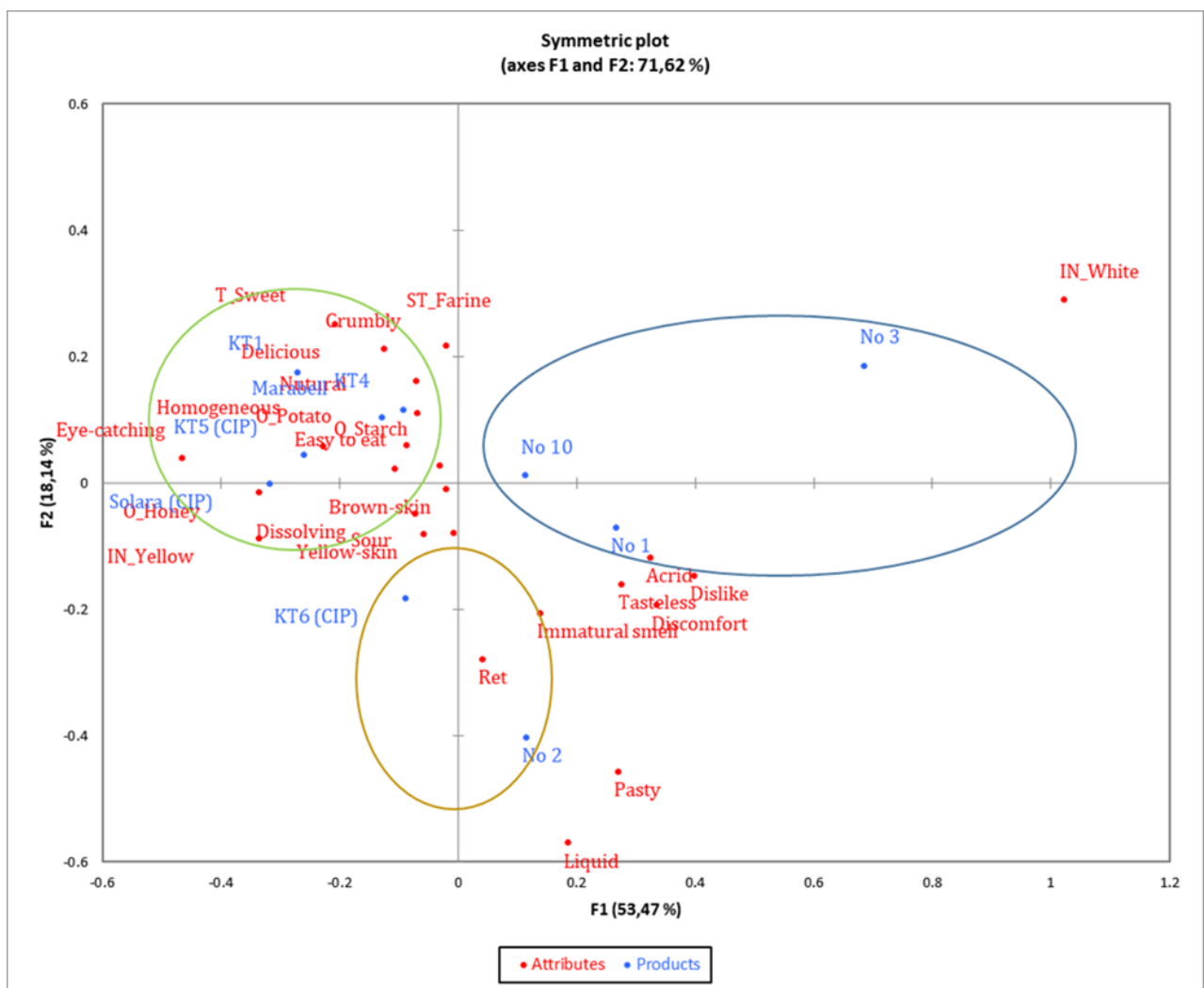

Figure 60. Products and attributes space as described by consumer panel

4. CONCLUSIONS

Our study, which is titled "Consumer Demand and Preferences for Boiled Potato and Sweetpotato in Hanoi, Vietnam", found the following results:

Part 1: Results for sweetpotatoes

Firstly, results from the QDA permitted to describe all studied samples by 22 sensory descriptors. Basing on their sensory characteristic descriptors, samples were separated in four groups (Beniazuma ; Red and white Hoang Long ;Khoai mat and China ;Khoai bo). In each group, they had similar sensory properties.

Secondly, results from the FGD collected consumers' habit on using sweetpotatoes. Hanoi end-users preferred *Japan purple varieties and domestic purple varieties*. They often *boil* and *grill* sweetpotatoes, and eat these roots *when being hungry as a kind of snacks.* The most important factor in product selection is *Quality*, and the second one is *Price*. The preferred sensory properties are *yellow inside*, *oblong shape, mealiness*, and *no strange characteristics* (ex: holes, black dots, cut/break...). The acceptable price should be between 10000-20000 VND/kg. Otherwise, there were some different opionions depending on consumers' age, gender, and income levels.

Thirdly, results from the consumer test showed that the most preferred sample was Beniazuma, and the least preferred one was White Hoang Long. Then, this result was combined with the QDA results by a preference mapping. In consequence, we could explain why consumers liked or disliked each product. And, we found that some descriptors correlated with liking scores, in positive way *([Peel]Red, [Peel]Brown, [In] Mealy)*, and in negative way *([In-Mouth] Soluble, [In-Mouth] Smooth, [Peel] Yellow, [In] Homogeneous).*

JAR results suggested the way to improve samples' preferrences. For Red Hoang Long and White Hoang Long varieties, *Yellow* and *Sweetness* need to be increase. However, for Beniazuma, *Softness* need to be increase and *Sweetness* need to be decrease. Penalty analysis of consumer data showed that sweetness and yellow (inside) were key drivers of overall liking.

Finally, CATA results explained better the hedonic test results by consumers' descriptions. Beniazuma was always the most preferred sample because of a composed descriptors: *Crumbly, Starchy-smell, Fine-surface, Comfort-smell (familiar, natural), Starchy-taste, Brown-peel, Easy to eat, Delicious.*

This study identified the priority characteristics which Hanoi users prefer for selecting roots for boiled sweetpotato.

Part 2: Results for potatoes

Similarly with the results of the part 1, we found some below important results for potato varieties.

Firstly, results from the QDA permitted to describe all studied samples by 36 sensory descriptors. Basing on their sensory characteristic descriptors, samples were separated in five with their characteristic descriptors.

Group	Products	Typical characteristics
1 (F1-2)	Solara, KT1	T_Sweet, ST_Fine, IN_Yellow, SK_Fine, ST_Soluble, SK_Yellow
2 (F1-2)	KT6, KT4	ST_Liquid, ST_Soft, ST_Homogenous, SF_Fine, SF_Shine
3 (F1-2)	No.3	ST_Uncooked, IN_White, SK_Brown, T_Greasy, O_Immature
4 (F1-2)	Marabell. KT5	IN_Yellow green, ST_Farine, O_Starch, SF_Dry, SF_Floury, T_Umami
5 (F1-3)	No.1, No.10	SK_Fine, ST_Uncooked, IN_Yellow, SK_Brown, ST_Sticky

Secondly, results from the FGD collected consumers' habit on using potatoes. Hanoi end-users often *make a soup (with pork bone, curry) and fry potatoes*, and eat these tubes in the main meals*.* The most important factor in product selection is *Price* and the second one is *Origin (Local origin is the most preferred, and Chinese one is the least preferred)*. The preferred sensory properties are *yellow inside*, *bold and medium side, firmness*, and *no green color*. The acceptable price should be between 10.000-20.000 VND/kg. Otherwise, there were some minor different opionions depending on consumers' age, gender, and income levels.

Thirdly, results from the consumer test showed that the most preferred samples were KT5 (CIP) and Marabell, and the least preferred ones were No1, No2, No3. Then, this result was combined with the QDA results by a preference mapping as well. In consequence, we could find the relationship between some sensory descriptors and liking scores, in positive way (*O_Cooked potato, IN_Green yellow, ST_Fine)*, and in negative way (*SF_Sticky, IN_Transparent, O_Rooted, O_Fresh potato, ST_Tender, SK_Red brown).*

Fourthly, JAR results suggested the way to improve the preferrences for each samples. There were a lot of descriptors needed to be increase to improve hedonic scores, such as *Yellow, Smell intensity, Soft, Wet, Farine, Sweet* for the least preferred sample No1.

Finally, CATA results explained better the hedonic test results by consumers' descriptions. The most preferred group, including KT1, KT4, Marabell, KT5 (CIP), Solara (CIP), was characterized by *fragrant, delicious, sweetpotato, powdery, easy to eat, natural, honey, even, sweet, eye-catching, yellow inside*. While the least preferred group, including No1, No3, No10, was characterized by *acid, dislike, tasteless, discomfort flavour*.

By understanding better preferences of consumers and the quality attributes they look for, this study may be useful to suggest processors the way to improve their products and to respond well consumers' expectations and preferences.

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6. ANNEXES

Annex 1. Discussion Guideline for Focus Groups

1. Introduction – Topic, Rules, Explanation of the Study

2. Warm up – Introduction of panelists

3. Discussion

- *Questions group 1: Reminding about Sweetpotatoes/potatoes*

  o What comes into your mind when talking about sweetpotatoes/potatoes?

  o In your opinion, how important is boiled sweetpotato/potato products, and why?

- *Question group 2: Focusing on boiled sweetpotato products*

  o Which kind/variety of sweetpotato/potato do you think is good for making boiled sweetpotatoes/potatoes?

  o Why are such kinds/varieties of sweetpotatoes/potatoes good for making boiled sweetpotatoes/potatoes?

  o Which kind/variety of sweetpotato/potato is not good for making boiled sweetpotatoes/potatoes? Why?

- *Question group 3: Preferred characteristics of fresh potatoes/sweetpotatoes*

  o What are the characteristics of the potato/sweetpotato you buy?

  o What are the three most important characteristics?

  o How do you know if a potato/sweetpotato has the characteristics you want? Rate importance. (The objective of the question was to understand the criteria that participants used to select potatoes for specific purposes of processing, storage, consumption, etc.).

  o For the top 3 characteristics: What effect does this feature have on your buying decision?

- *Question group 4: About how sweetpotatoes/potatoes were used*

  o List of potato/sweetpotato varieties

  o Who uses those varieties?

- o Are those varieties available in the community/region you live in?

- o In your area in particular and in Hanoi in general, who do you notice selling each of the varieties listed in the first column? Survey on family members, gender and social segment (income).

- o What are the important features of this product?

- *Question group 5: Disliked characteristics in potatoes*

  - o What characteristics do you dislike about potatoes? (Please describe in detail)

  - o Why are they disliked?

- *Question group 6: Group of questions related to product preparation and processing*

  - o What are the steps to prepare and cook boiled potatoes/sweetpotatoes?

  - o Who usually does this step? (Need to survey on social segment, are outsourcers or family members, ...)

- *Question group 7: About liking*

  - o How would you describe a high quality boiled potato/sweetpotato product?

  - o What are the three most important characteristics? List in order of importance

  - o How do you know this product has those characteristics?

- *Question group 8: About dislike*

  - o How would you describe disliked boiled potato/sweetpotato product?

  - o What are the three most important characteristics? List in order of importance

  - o How do you know this product has those characteristics?

- *Question group 9: Questions about consumption habits*

  - o What made you decide to eat sweetpotatoes/potatoes instead of other products?

- How often do you consume sweetpotatoes/potatoes?

- Why are sweetpotatoes/potatoes important in your diet? How important is it in your diet?

- When do you usually eat potatoes? When are sweetpotatoes/potatoes used in your household?

- What do you usually eat with potatoes?

- *Question group 10: Group of questions of quality improvement and sweetpotato development*

  - What criteria do you think the sweetpotato/potato products you have used need to be more complete?

  - What is your idea about sweetpotato/potato (or sweetpotato/potato usage) that you like but haven't seen on the market?

CONSUMER QUESTIONAIRE OF BOILED SWEETPOTATOES

Day: ....

Dear Sir/Madam!

Our team is conducting a survey about boiled sweetpotato. We appreciate for spending your time to participate in this survey. Please mark (X) in the blank box that you choose. There is no right or wrong answers, all your honest answers are valuable information and important for our research. Thank you so much for your participation!

Part 1: General Information

Please provide the following information. We promise that your information will be kept confidential and used only for research purposes:

1. Gender

❑ Male ❑ Female

❑ Other

2. Age

❑ 18-23 ❑ 24-30

❑ 31-40 ❑ >40

3. Income

❑ < 3 million VND/month ❑ From 3-5 million VND/month

❑ Greater than 5 to 10 million VND/month ❑ More than 10 to 15 million VND/month

❑ More than 15 to 30 million VND/month ❑ > 30 million VND/month

4. Marital Status

❑ Single ❑ Married, no children

❑ Married and have children ❑ Other

5. Occupation: ....

6. We can keep contact with you by:

Telephone No.: ....

Email: ....

Part 2: Habits of sweetpotato consuming

1. When mentioning to sweetpotato products, what do you image? (choose multiple answers)

☐ Safety	☐ Winter	☐ Honey
☐ Farina	☐ Countryside	☐ Yellow
☐ Easy to eat	☐ Folk	☐ Purple
☐ All ages	☐ Healthy diet	☐ Orange
☐ Cheap	☐ Sweet	☐ Sticky teeth
☐ Happy	☐ Sad	☐ Bùi (sweet and odorous)
☐ Boiled sweetpotatoes	☐ Baked sweetpotatoes	☐ Other dishes

2. Which type of sweetpotato do you prefer?
- ☐ Yellow sweetpotatoes
- ☐ White sweetpotatoes
- ☐ Like both types equally

3. What do you like that kind of sweetpotato for?

……………………………………………………………………………………………

………………………………………………………

4. How often do you eat sweetpotatoes?
- ☐ Unstable. More in winter, less in summer
- ☐ Unstable. More in summer, less in winter
- ☐ Permanent. Several times per quarter
- ☐ Permanent. Several times per month
- ☐ Permanent. Several times per week

5. How much do you usually eat each time?
- ☐ A few thin slices
- ☐ Half tuber - one tuber
- ☐ A few of tuber
- ☐ Other: ………………

6. What time of day do you usually eat sweetpotatoes?
- ☐ Breakfast
- ☐ Lunch
- ☐ Supper
- ☐ Dinner
- ☐ After dinner
- ☐ No fixed time
- ☐ Other: ………………

7. What is your reason for eating sweetpotatoes?
- ☐ Health benefits (diet, laxatives, fiber supplements, collagen regeneration, etc.)
- ☐ Interests
- ☐ Craving (suddenly)
- ☐ The context is reminiscent of eating sweetpotatoes (winter, coming home, having a wood stove, ...)
- ☐ Meal of the day

8. What's your favorite sweetpotato dish?
- ☐ Boiled sweetpotatoes
- ☐ Baked sweetpotatoes
- ☐ Sweet sweetpotato dessert
- ☐ Sweetpotato cakes
- ☐ Sweetpotato cocoon
- ☐ Cooking with curry
- ☐ Dried Sweetpotatoes
- ☐ Cooking with hot pot
- ☐ Other:…………………….

9. Choosing 3 things you don't like about sweetpotato products? (If sweetpotato is improved on these things, you will eat more sweetpotatoes.)
- ☐ Easy to get rooted
- ☐ Sticky teeth
- ☐ Easy to bored
- ☐ Easy to full stomach
- ☐ Hard to peel
- ☐ Sticky teeth
- ☐ Fibrous
- ☐ Transparent intestine
- ☐ Other:………………

10. When you eat sweetpotatoes, what do you eat with them?
- ☐ Eat with salted Vietnamese eggplant
- ☐ Sugar
- ☐ Nothing
- ☐ Other: ………………

11. How often do you buy sweetpotatoes?
- ☐ Several times/week
- ☐ Several times/month
- ☐ 1 time/month
- ☐ Several times/year
- ☐ Other: ………………

12. How much do you buy each time?
- ☐ 1-2 tubers
- ☐ 5-6 tubers or more
- ☐ 1-2 kg
- ☐ 5-6 kg
- ☐ 10 kg
- ☐ Other: ………………

13. Do you usually buy raw or cooked sweetpotatoes?
- ☐ Raw sweetpotatoes
- ☐ Cooked sweetpotatoes
- ☐ Unstable

14. Does the price of sweetpotatoes often fluctuate?
- ☐ No
- ☐ Yes
- ☐ Do not know. If sweetpotato's price change, I don't mind
- ☐ Other: ………………

15. Where do you usually buy sweetpotatoes?
- ☐ Traditional markets
- ☐ Wholesale markets
- ☐ Supermarket

☐ Online

☐ Other: ………………

16. Are there multiple purchase options?

☐ Depending on the season. In general, little

☐ Depending on the season. Overall, it's diverse

☐ Other: ………………

17. When buying sweetpotatoes, are you concerned about safety?

☐ 100% don't notice

☐ Little interest, sometimes pay attention. Overall sweetpotato is safe

☐ Always worried

Part 3: Taste the product

You will receive 2 sets of product, 5 coded samples each turn. Please observe and taste according to the instructions and answer the questionnaire on the following page.

Instruct:

- *Step 1*: Start tasting in order from left to right, one by one
- *Step 2*: Find the sample code on the disc and write it in the section "***Sample No***".
- *Step 3*: Observing, tasting each sample carefully and answer the questions below
- *Step 4*: After finishing your answers, please notify the instructor to check the questionaire and receive the gift.

Note: After tasting each product, please use water to rinse your taste before moving on to the next sample!

Tester name: _____

Sample No.: _____

1) Taste and indicate your GENERAL LIKING for this sample is:

☐	☐	☐	☐	☐	☐	☐
Very Disliked	Dislike	Slightly disliked	Don't like don't dislike	Slightly like	Like	Very like

2) Observe and indicate your APPEARANCE LIKING (sweetpotato color, peel color, surface …) for this sample is:

☐	☐	☐	☐	☐	☐	☐
Very Disliked	Dislike	Slightly disliked	Don't like don't dislike	Slightly like	Like	Very like

3) Observe and indicate your FLAVOR LIKING for this sample is:

☐	☐	☐	☐	☐	☐	☐
Very Disliked	Dislike	Slightly disliked	Don't like don't dislike	Slightly like	Like	Very like

4) Observe and indicate STRUCTURE in mouth LIKING (farina, sticky,) for this sample is:

☐	☐	☐	☐	☐	☐	☐
Very Disliked	Dislike	Slightly disliked	Don't like don't dislike	Slightly like	Like	Very like

5) After tasting, what word do you think that is suitable to describe the sample (you can choose multiple answers or none in each row):

overall	☐ Dislike	☐ Easy to eat	☐ Hard to peel	☐ Discomfort	☐ Nature
	☐ Familiar	☐ Liquid	☐ Farina	☐ Eye- catching	☐ Delicious
Appearance	☐Yellow Intestines	☐ Wet Water	☐Smooth surface	☐Yellow peel	☐ Brown peel
	☐White Intestines	☐ Homogenous			
Odor	☐ Sweetpotato	☐ Honey	☐ Starch	☐ Immartural smell	☐ Acrid
	☐ Pleasant	☐ Burn			
Taste/Flavor	☐Sweet	☐Sour	☐ Tasteless	☐ Sweetpotato	☐ Starch taste
Structure in the mouth	☐ Multiple fiber	☐ Sticky teeth	☐ Ret	☐ Pasty	☐ Mealy
	☐ Hard to eat	☐ Dissolve			

6) What do you think about the last sample about the following properties:

	☐	☐	☐		☐	☐	☐
Yellow (intestines)	Less	JAR	Much	**Wetness of the face**	Less	JAR	Much
	☐	☐	☐		☐	☐	☐
Odor intensity	Less	JAR	Much	**Mealy**	Less	JAR	Much
	☐	☐	☐		☐	☐	☐
Softness	Less	JAR	Much	**Sweet**	Less	JAR	Much

Thank you very much for participating!

Annex 3. Questionnaires for Potatoes

CONSUMER QUESTIONAIRE OF BOILED POTATOES

Day: ....

Dear Sir/Madam!

Our team is conducting a survey about boiled potato. We appreciate for spending your time to participate in this survey. Please mark (X) in the blank box that you choose. There is no right or wrong answers, all your honest answers are valuable information and important for our research. Thank you so much for your participation!

Part 1: General Information

Please provide the following information. We promise that your information will be kept confidential and used only for research purposes:

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❑ Single ❑ Married, no children

❑ Married and have children ❑ Other

5. Occupation: ....

6. We can keep contact with you by:

Telephone No.: ....

Email: ....

Part 2: Habits of potato consuming

1. When mentioning to potato products, what do you image? (choose multiple answers)

☐ Safety ☐ Winter ☐ Honey
☐ Farina ☐ Countryside ☐ Yellow

☐ Easy to eat	☐ Folk	☐ Purple
☐ All ages	☐ Healthy diet	☐ Orange
☐ Cheap	☐ Sweet	☐ Sticky teeth
☐ Happy	☐ Sad	☐ Bùi (sweet and odorous)
☐ Boiled potatoes	☐ Baked potatoes	☐ Other dishes

2. Which type of potato do you prefer?
- ☐ Yellow potatoes
- ☐ White potatoes
- ☐ Like both types equally

3. What do you like that kind of potato for?

…………………………………………………………………………………………

……………………………………………………

4. How often do you eat potatoes?
- ☐ Unstable. More in winter, less in summer
- ☐ Unstable. More in summer, less in winter
- ☐ Permanent. Several times per quarter
- ☐ Permanent. Several times per month
- ☐ Permanent. Several times per week

5. How much do you usually eat each time?
- ☐ A few thin slices
- ☐ Half tuber - one tuber
- ☐ A few of tuber
- ☐ Other: ………………..

6. What time of day do you usually eat potatoes?
- ☐ Breakfast
- ☐ Lunch
- ☐ Supper
- ☐ Dinner
- ☐ After dinner
- ☐ No fixed time
- ☐ Other: ………………..

7. What is your reason for eating potatoes?
- ☐ Health benefits (diet, laxatives, fiber supplements, collagen regeneration, etc.)
- ☐ Interests
- ☐ Craving (suddenly)
- ☐ The context is reminiscent of eating potatoes (winter, coming home, having a wood stove, ...)
- ☐ Meal of the day

8. What's your favorite potato dish?

☐ Boiled potatoes	☐ Potato cakes	☐ Dried Potatoes
☐ Baked potatoes	☐ Potato cocoon	☐ Cooking with hot pot

☐ Sweetpotato dessert   ☐ Cooking with curry   ☐ Other:……………………

9. Choosing 3 things you don't like about potato products? (If potato is improved on these things, you will eat more potatoes.)

☐ Easy to get rooted   ☐ Easy to full stomach   ☐ Fibrous

☐ Sticky teeth   ☐ Hard to peel   ☐ Transparent intestine

☐ Easy to bored   ☐ Sticky teeth   ☐ Other:………………

10. When you eat potatoes, what do you eat with them?

☐ Eat with salted Vietnamese eggplant

☐ Sugar

☐ Nothing

☐ Other: ………………

11. How often do you buy potatoes?

☐ Several times/week

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☐ 1 time/month

☐ Several times/year

☐ Other: ………………

12. How much do you buy each time?

☐ 1-2 tubers

☐ 5-6 tubers or more

☐ 1-2 kg

☐ 5-6 kg

☐ 10 kg

☐ Other: ………………

13. Do you usually buy raw or cooked potatoes?

☐ Raw potatoes

☐ Cooked potatoes

☐ Unstable

14. Does the price of potatoes often fluctuate?

☐ No

☐ Yes

☐ Do not know. If potato's price change, I don't mind

☐ Other: ………………

15. Where do you usually buy potatoes?

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Sample No.: _____

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☐	☐	☐	☐	☐	☐	☐
Very Disliked	Dislike	Slightly disliked	Don't like don't dislike	Slightly like	Like	Very like

2) Observe and indicate your APPEARANCE LIKING (potato color, peel color, surface ...) for this sample is:

☐	☐	☐	☐	☐	☐	☐
Very Disliked	Dislike	Slightly disliked	Don't like don't dislike	Slightly like	Like	Very like

3) Observe and indicate your FLAVOR LIKING for this sample is:

☐	☐	☐	☐	☐	☐	☐
Very Disliked	Dislike	Slightly disliked	Don't like don't dislike	Slightly like	Like	Very like

4) Observe and indicate STRUCTURE in mouth LIKING (farina, sticky,) for this sample is:

☐	☐	☐	☐	☐	☐	☐
Very Disliked	Dislike	Slightly disliked	Don't like don't dislike	Slightly like	Like	Very like

5) After tasting, what word do you think that is suitable to describe the sample (you can choose multiple answers or none in each row):

overall	□ Dislike	□ Easy to eat	□ Hard to peel	□ Discomfort	□ Nature
	□ Familiar	□ Liquid	□ Farina	□ Eye- catching	□ Delicious
Appearance	□Yellow Intestines	□ Wet Water	□Smooth surface	□Yellow peel	□ Brown peel
	□White Intestines	□ Homogenous			
Odor	□ Potato	□ Honey	□ Starch	□ Immature smell	□ Acrid
	□ Pleasant	□ Burn			
Taste/Flavor	□Sweet	□Sour	□ Tasteless	□ Potato	□ Starch taste
Structure in the mouth	□ Multiple fiber	□ Sticky teeth	□ Ret	□ Pasty	□ Mealy
	□ Hard to eat	□ Dissolve			

6) What do you think about the last sample about the following properties:

	□	□	□		□	□	□
Yellow (intestines)	Less	JAR	Much	**Wetness of the face**	Less	JAR	Much
	□	□	□		□	□	□
Odor intensity	Less	JAR	Much	**Mealy**	Less	JAR	Much
	□	□	□		□	□	□
Softness	Less	JAR	Much	**Sweet**	Less	JAR	Much

Thank you very much for participating!