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Analysis of the Organoleptic Properties of *Solanum Tuberosum* or Potato, Gahinga and PENAP Varieties Grown in Goma

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Abstract. To subscribe to the dynamics of the efforts to fight against malnutrition, to ensure food self-sufficiency, to challenge poverty and to answer the objectives of sustainable development in the world in perpetual mutations, this work centered on the presentation of the organoleptic properties of the varieties Gahinga and PENAP of *Solanum tuberosum* L. or potato has been initiated. Its content is one of the means that species breeders use to achieve their objective, that of seeking to adapt the actions to new varieties. These varieties are born and reveal a great diversity of properties, shapes, colors, sizes, aromas and constituents or nutritional compounds, of foodstuffs.

This effort started from the question whether the organoleptic properties of two varieties of *Solanum tuberosum* L., Gahinga and PENAP, can prove the improvement of this commodity in the production system of food crops.

Before the field investigations, it was found that the determination of the organoleptic properties of two varieties of *Solanum tuberosum* L., Gahinga and PENAP, would be a sufficient and easily applicable means to detect and confirm the improvement of the potato in the food crop production system. This was even confirmed by the results of laboratory analysis.

In obtaining these results, a variety of materials and techniques were used under the experimental method, supported by the laboratory.

By their organoleptic properties it will be noticed, that the variety PENAP is more improved than Gahinga. By its food value or its characteristics relative to the quantity of water, sugars, and mineral salts, PENAP encourages more the consumers. Its frying consumes less oil, so it preserves human health and development.

Key words: potato, organoleptic properties, plant breeding, Gahinga, PENAP, *Solanum tuberosum*

Introduction

The concern for research and strengthening local initiatives for development is multisectoral. With the improvement and selection of species, it is part of the dynamics of efforts to fight against malnutrition, ensure food self-sufficiency, challenge poverty and meet the objectives of sustainable development in a world in perpetual change. On a smaller scale, it is a way of strengthening food security and preserving the income and yields of producers (Bathelot, 2016).

To operationalize or concretize the improvement and selection of species, the present work focused on the presentation and comparison of organoleptic properties of varieties of *Solanum tuberosum* L. or potatoes in their production system is carried out (François *et al*., 2005).

Based on MUMBA (2021), there is a difference between improvement and selection of species. Selection is a choice of individuals in order to facilitate their production. In contrast, species or plants cannot be improved without being selected.

The improvement or creative selection of species or plants is a technical approach, a practice that applies the rules of genetics to plant reproduction. It is an agronomic science that is the basis of seed production (seed industry), involving several sciences.

Under this effort, a research question was targeted. Can the organoleptic properties of Gahinga and PENAP, two varieties of *Solanum tuberosum* L., prove the improvement of this commodity in the productive system of food plants? Before any field investigation, the anticipatory answer to the experimental question shows that the determination of the organoleptic properties of Gahinga and PENAP, two varieties of *Solanum tuberosum* L., would be a sufficient means to detect and confirm the improvement of the potato in the productive system of food plants.

Its objectives are continuous and complex. On a regular basis, to make the cultivated plants produce a lot and increase their yield, in order to feed the populations well, allow them empowerment and elevation of living standards (Bathelot, 2016).

In its practice plant breeding presents three possibilities:

- ✓ The possibility of meeting ecological and trophic needs;
- ✓ The possibility of creating cultivated varieties that are more productive and adapted to the environment; and
- ✓ The other to protect the crop (François et al., 2005).

During the improvement process, a process is activated that requires sufficient scientific knowledge and knowledge of the target plant. This knowledge integrates the biology of the plant, its cultivation route and even its ecology. During the improvement process, the cultivation techniques are combined with the possibilities of increasing the yield. The vegetative cycle is accelerated and even synthetic products can be transferred from the leaves to the fruits (François et al., 2005).

The improvement of the yield of the plants in culture concerns the quantitative and qualitative aspects. With it a plant is selected, for example, for its organoleptic properties, its richness in important nutrients, the appearance of the product, the yield in processing, the resistance to transport and the ease of conservation (Bathelot, 2016).

The potato has several varieties. Among them, in Cameroon are registered the varieties Cipira, Tubira, Bambui wonder, Jacobs 2005, IRAD 2005 and Maffo, launched by the national research program through the Institute of Agricultural Research for Development IRAD.

In this group, the varieties Cipira and Tubira are the most widespread. They have been widely adopted because of their high production potential and tolerance to the devastating disease, downy mildew. IRAD has also released several other varieties through evaluations and tests of adaptability of CIP germplasm. These are varieties that are available and provide good quality potato seed (IRAD, 2012).

Over the past few decades, other varieties have been evaluated over a wide range of ecology, with different results. "Local" varieties and so-called "European" varieties such as Cardinal, Désirée, Diamant, Hydra, Kondor, Roman and Spunta are also grown. On this list, the newest varieties are Dosa, Panamera, Jacob, Pamina, Joelle, Jelly, Bavapom, Sevim, and Krone (Weidmann et al., 2019).

In Canada, researchers have found fifteen varieties with different and specific properties with some similarities. These are the varieties Beljade, Merlin, Roko, Mozart, Estima, Russet Burkank, Chieftain (DRC), Peribonka, Viking, Gabrielle, Raphaelle, Vivaldi, Goldrush, Reba and Yukon Gold (Vincent & Ferland, 2017).

In the DRC, especially in the East, the varieties encountered are: PNAP, Gahinga, Kinigi, Tiret 58, Carolis, Mwezi moya, Précoce, Kiganya, Kirundo, Cruza and Clone. Practiced as monocultures on ridges, all of these varieties are better adapted to the large hills of the East, but unfortunately are mostly exploited by farmers. Hence the great challenges facing the potato sector in the zone; given that large entrepreneurs are not really interested in it. (Arhagererwa, 2018).

Regarding potato cultivation, the plants prefer temperatures between 10 and 22 ^{0}C with an average of 15 ^{0}C. For this reason, they are grown at higher altitudes up to 1900 meters. Potatoes adapt best in a balanced climate and have a fairly high water demand. Especially, the maximum need of water is manifested since the bloom and during the tuberization. Its cultivation requires a well-distributed rainfall of 500 to 750 mm at all stages of growth during a period of 3 to 4.5 months (François et al., 2005).

This crop is particularly sensitive to long wet or dry periods during flowering and tuberization. Waterlogging as well as dry soil are not favorable for tuber production. If potato is grown during dry periods or in areas with low or irregular rainfall, irrigation is usually necessary (Bathelot, 2016).

Relative to thermoedaphic conditions for the crop, the minimum soil temperature required at planting is 8°C. This crop is disadvantaged on compact, poorly drained and stony soil. Light to medium and loose soils, rich in organic matter, with an appropriate depth and a pH of 5.5 to 7 are ideal or favorable. For good production, these soils must be well drained to avoid waterlogging and at the same time have a good retention capacity to ensure a regular supply of water. Soils that are too stony, shallow, compacted and poorly drained are not suitable. On lighter soils, tubers generally develop a more beautiful shape and color as well as flatter eyes. On heavy soils, tubers have smoother skin and less scab. Fast-drying sandy soils result in rougher, russet skins and scab infection. Soils with a pH below 5.0 cause poor tuber quality and abnormal growth, while high pH causes problems with common scab. Because of their low nutrient content and low base exchange capacity, widespread acidic lateritic soils are naturally low in fertility and have low production potential. However, appropriate soil fertility management measures, such as adding organic matter to the soil, increasing soil pH by liming, applying compost and irrigation, make them suitable for cultivation (FIBL, 2007; Wabenga, 2018).

With regard to tuber storage, potatoes harvested when fully ripe can be stored for ten to twelve months. The question of storage arises for so-called "storage potatoes" as well as for those intended for industrial processing and seed. Tubers, which are alive and have a high water content, undergo respiration and transpiration. They are subject over time to weight loss, wilting and sprout development. They can also be exposed to risks of fermentation and bacterial or fungal attacks. They must be protected from frost. For potatoes, the storage conditions to be respected are the following: Darkness, controlled ventilation and hygrometry, temperature maintained between 4 to 6°C. Anti-sprouting treatments are authorized during storage with substances such as propham or chlorpropham by powdering or fogging. The latter technique ensures a better distribution of the product and avoids the risks of localized overdosing, or by ionization (FIBL, 2007).

Potato tubers should not be refrigerated. They like dry, dark and cool places. A cold room or basement closet is suitable. If possible, it is advisable to remove them from their packaging bag and lay them on a flat surface so that they do not touch each other and become contaminated. Potatoes can be stored for up to 6 months, but the colder the temperature or the

more moisture they are exposed to, the less time they will survive. And depending on the variety, the consumer can keep potatoes for several weeks in a cool, dark place. "Early" potatoes, harvested before full maturity, can be stored for only a few days (Wabenga, 2019).

The organoleptic properties of food and foodstuffs include their physical and chemical characteristics perceived by the sense organs and provoking in people emotional reactions of varying intensity. These properties are not limited to the sense of taste or smell, but also affect sight and touch, while avoiding hearing. They encompass different classes and forms of stimuli including mechanical, chemical and sensory stimuli or perceptions. That is, in addition to the taste of food, these properties show the texture, smell, aroma, color and even temperature of food, for consumption (Bathelot, 2016).

The determination or study of organoleptic properties is important for comparisons used in the tasks of selection and improvement of species and in those branches of science where it is usual to initially assess the characteristics of the material without the help of sophisticated measuring instruments. These characteristics are also of economic interest to professionals and/or consumers of typical foodstuffs. Organoleptic indices are the content or relative quantities of elements such as water, sugar, salts and metabolizable proteins and can be judged by sensory factors such as color, odor, taste or turbidity and confirmed by biochemical analysis in the laboratory. These indices are to be distinguished from physico-chemical parameters such as temperature, pH and conductivity. Overall, these characteristics are summarized in three general properties that are evaluated more or less consciously, in the following chronological order: Mechanical characteristics or stimuli, chemical characteristics, reinforced by taste perceptions and sensations, and economic characteristics (FIBL, 2007).

The stimuli, mechanical characteristics or properties are summarized in the shape, size, color and, at first sight, the texture and the state or sharpness (smooth to the touch, fresh to the nose, etc.) of the food.

In a complex way, they are perceived by touch and in some cases, with the intervention of hearing (Bathelot, 2016).

In their manifestations, mechanical stimuli tend to influence or even alter the gustatory perception of food. They trigger or inhibit the efforts and the mechanical capacities relative to crunch or eat. With them, the pressures and rubbings of the food solicit the mechano-receptors of the individuals, which triggers an action potential to the involved nerves.

The characteristics or chemical stimuli of the food are summarized in the establishment "quantifiable" by the smell and the taste, under the prerogative of the chemoreceptors located in the tongue and the nose.

It is a question of evaluating or identifying the substances like Na+, glutamates or other ionic groups in solution of a foodstuff and their concentration able to activate the olfactory and gustatory receptors. They activate by binding to cellular receptors, to mobilize the nerves to direct a response of value (Bathelot, 2016).

The sensation of taste is complex. It covers several perceptions, smell and touch, even sight. Similarly, the effects of substances olfactory and gustatory active in foodstuffs are conditioned by several physical aspects such as their solubility and their diffusion in liquid phase as gas. In addition, there are purely physical perceptions such as temperature, pressure or texture or consistency in the mouth (FIBL, 2007).

The economic interest of a foodstuff marks the character of this commodity that can be appreciated by the human senses (touch, taste, hearing, smell), while impacting a good order established in its expenditure, consumption, administration, distribution and saving or accumulation and services to which it can be attached. From these and other elements, the events, sensations or feelings of the organoleptic perception of the foodstuffs are diverse and specific. These events are manifested in greater or lesser intensity depending on the impact

that the properties have on individuals. Among these feelings are pleasure, satisfaction, joy, indifference or not, discomfort or comfort, discomfort and repulsion (FIBL, 2007).

In the evaluation of organoleptic sensations, there is not a single quality or characteristic, but several that are told through the needs, the equipment on board or each related presentation (Bathelot, 2016).

In agriculture, edaphology is the determination of the class of soil texture. It is carried out in the field by the organoleptic method, which mainly combines sight, touch and sometimes taste. This method requires a lot of practice on the part of the evaluator. As such, even if the obtained appreciations are very close to the real appreciations, the organoleptic method does not stop being an estimation method. If a more precise determination of the soil texture is required, a laboratory analysis is always recommended (Dumas & Sauvageot, 2022).

The central question for this research is what are the organoleptic properties of two potato varieties?

To answer this question, there are several potato properties. The objective is to determine the different organoleptic properties of two potato varieties.

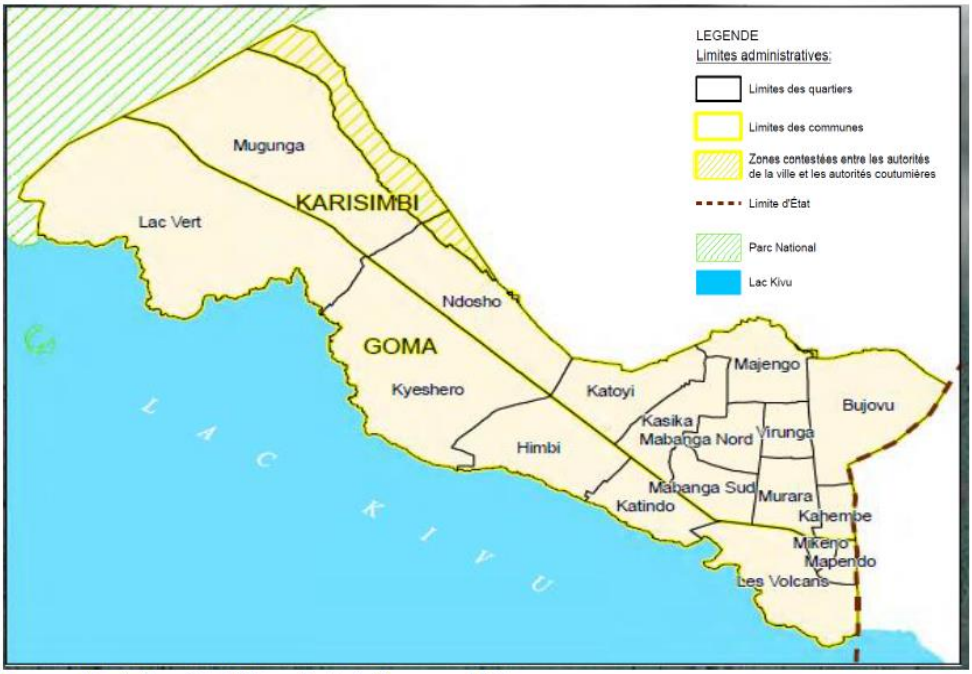
Materials and Methods

Environment

The field activities of the present study were carried out in the city of Goma in North Kivu, in the Democratic Republic of Congo, at an altitude of 1500 m.

In terms of ecoclimate, the city of Goma is located in the mountainous region, particularly in the eastern part of the Democratic Republic of Congo. In this part, there are mountain ranges, linked to the Great Rift Valley, which has also produced a number of lakes, such as Lake Albert (at 615 m), Lake Edward (at 915 m), Lake Kivu (at 1465 m), Lake Tanganyika (at 770 m), and Lake Moero (at 920 m).

1. Daytime temperatures are pleasant all year round, and cool at night.
2. The sunniest period is the relatively dry period from June to August.
3. Rainfall in Goma reaches 1,250 millimeters per year; from June to August the rains are quite scarce.



Source : Musée Royal de l'Afrique Centrale, Tervuren, 2016

In part, the meteorological coordinates of the city of Goma are recorded in Table 1.

Table 1: Part of the meteorological coordinates of the city of Goma in general and the experimental site in particular

Months	Jan.	Feb.	March	April	May	June	July	August	Sept.	Oct.	Nov.	Dec.	An.
Average minimum temperature, in °C	14	14	14	14	14	13	13	13	13	13	13	13	13,4
Average maximum temperature, in °C	25	25	25	25	25	25	25	25	25	25	25	24	24,9
Average temperature, in °C	19,5	19,5	19,5	19,5	19,5	19	19	19	19	19	19	18,5	19,15
Sunshine Hours Daily	5,5	5,5	5	5,5	5,5	7	7,5	5,5	6	5,5	6	5,5	5,9
Rainfall in mm	115	95	110	140	135	45	30	65	115	150	145	120	1265

Source: Field Observation Sheet No. 1; Extract from meteorological data of the city of Goma, Department of Geodesy and Geochemistry (OVG, 2021)

Under this panel, in the city of Goma, the temperature was moderated by the proximity of Lake Kivu, the relief was accessible to acceptable ecological conditions and the rainfall abundant. The influences of the surrounding mountains and the proximity of Lake Kivu, are the main elements of the climate.

Materials

The materials used included:

1. The biological materials of which the varieties of *Solanum tuberosum* L. or potato, Gahinga and PENAP in stock of 2 kg bought at the Market of Majengo, in Commune of Karisimbi in Goma in DRC.
2. The non-biological materials are : the basins, the brazier, the pans, the knife, the dryer, the tray, the indicator papers, the pestle, the marking pen, the mortar, the filter paper, the tables, the pH meter, a razor blade, the packaging, the scissors, the bottles, the test tubes, the Mixer or the grinder, the funnel, the beakers, the micropipette, the pH meter of the Mulwaukee model, the Lithmus paper Refractometer for the determination of the quantity and content of sugar, Pasteur pipettes, pH calibration, office equipment, Imperial precision balance, recording forms or tools that allowed us to record the data, the computer tool, with Microsoft Word, Microsoft Excel and SPSS software for text entry and processing of analytical data.

Methods

With Filiberto et al. (2012), to reconcile theory with practice, sensory analysis uses the human senses to evaluate the organoleptic characteristics of food products in general and potatoes in particular. Contrary to the simple tasting, this analysis, as a scientific method, requires that the conditions in which the evaluations take place are perfectly controlled and mastered. This is because the human being is influenced during his evaluation by many external factors such as the environment in which he finds himself, his state of satiety, the

order in which the products are presented to him and the appearance of the samples. It is therefore essential to take a minimum of precautions, without which any interpretation of results is hazardous.

In order to ensure the reliability and validity or otherwise of the hypothesis formulated, in addition to the theoretical approach or the exploitation of existing literature, this work was carried out partly in the laboratory, the Marc laboratory supply, located in the Commune of Karisimbi, opposite the Virunga Market, in Goma DRC.

In the laboratory, three samples were isolated from each of two potato varieties, Gahinga and PENAP.

With three replicates, on each sample we performed the visual test, the tasting test, the biochemical tests of carbohydrates as well as the gravimetric analyses for the identification and the evaluation of nutritional compounds.

The results obtained are the averages of the observations received on each of the tests or analyses performed. These results are recorded in the table of results in the following section.

In the field, under the experimental method, a variety of techniques were used with different materials.

The techniques used are the following:

- ✓ Direct and participatory observation of specimens of *Solanum tuberosum* L. or potato, Gahinga and PENAP varieties and variations in organoleptic properties sought;
- ✓ Sampling of the varieties of *Solanum tuberosum* or potato, Gahinga and PENAP from a stock bought at the market of Majengo, in Commune of Karisimbi in Goma;
- ✓ The cutting of potatoes into pieces and their cooking
- ✓ The coloring technique with biochemical tests for carbohydrates and proteins as well as gravimetric tests for water and mineral salts in solution.
- ✓ The technique or the tasting test.

Results and Discussions

Results

Technically, in relation to the presentation of the organoleptic properties of the Gahinga and PENAP varieties of *Solanum tuberosum* or potato, the results of analysis in the laboratory are recorded in the table as follows:

N°.	Criteria	Variety Gahinga	Variety PENAP
1	Color of tuber flesh	Yellowish	White
2	Taste	Salty	Sweet
3	Texture	Catfish	Soft
4	pH	6,5	6,7
5	Relative humidity	70,27%	56,96%
6	Carbohydrate	14	18
7	Starch	15	19
8	Calcium salt (Ca)	3,65%	6,12%
9	Magnesium salt (Mg)	5,17%	7,08%

From these results, starting from the pH, there are no significant differences for acidity in two varieties of *Solanum tuberosum* L., Gahinga and PENAP.

As for the water content and the levels of mineral salts and sugars, the PENAP potato is more concentrated and less diluted than Gahinga.

Discussion

The results showing differences in the organoleptic properties of the Gahinga and PENAP varieties of *Solanum tuberosum* L. coincide with those of Sophie Vincent and Isabelle Ferland, obtained in their work on the characterisation of 15 potato varieties in Quebec in 2017. The potato presents several varieties, with different and specific organoleptic and other properties with some similarities (Vincent & Ferland, 2017).

These results also meet the work of Gilles Weidmann, Irene Kadzere, Paul van den Berge & Lina Tennhardt in Cameroon in 2019. By their characteristics or properties, among users, farmers and processors on the one hand and consumers on the other, some varieties are more appreciated and preferred than others.

Under a broader panel, integrating organoleptic characteristics, the choice of varieties in potato production depends on the intended use, consumer preferences, potential yield, pest and disease resistance, adaptation to local growing conditions and available planting material (Weidmann, 2018).

With biotechnologies in the form of genetic engineering, applied to species selection, in the face of ecological or environmental conditions that can be standardised or controlled, the differences in the organoleptic properties of the Gahinga and PENAP varieties of *Solanum tuberosum* L., in the Goma environment, DRC are partly related to the character effects, genes or DNA of each of the two varieties. These genes induce chlorophyll functions and the formation of compounds responsible for typical properties differently.

Conclusion

Following the expectations of consumers in the ever-changing world and the subscription to the dynamics of the efforts to fight malnutrition, ensure food self-sufficiency, challenge poverty and meet the objectives of sustainable development, this study focused on the analysis of the organoleptic properties of the Gahinga and PENAP varieties of *Solanum tuberosum* L. or potato was initiated. With these expectations, improving the organoleptic qualities of foods is one of the objectives of species breeders. Breeders and farmers are constantly seeking to adapt their actions to new varieties. These are emerging and revealing a great diversity of properties, shapes, colours, sizes, aromas and nutritional constituents or compounds of foodstuffs.

The work started from the research question: Can the organoleptic properties of two varieties of *Solanum tuberosum*, Gahinga and PENAP, prove the improvement of this commodity in the food crop production system?

Prior to the field investigations, it appeared that the determination of the organoleptic properties of two varieties of *Solanum tuberosum* L., Gahinga and PENAP, would be a sufficient and easily applicable means to detect and confirm the improvement of the potato in the food crop production system. This was even confirmed by the results of the laboratory analyses.

To obtain these results, a variety of materials and techniques were used under the experimental method, supported by the laboratory.

The organoleptic properties of both varieties show that PENAP is more improved than Gahinga. By its food value or its characteristics relating to the quantity of water, sugars, and mineral salts, PENAP encourages more consumers. Its deep-frying consumes less oil, so it preserves human health and development.

Although intended use, yield potential and customer preferences play an important role in varietal selection, with organic agriculture, the approach of a set of agricultural practices that respect the balance of nature and the well-being of living beings as an alternative to the "sustainable" productivist agricultural model is supporting plant breeding.

Similarly, good growth characteristics and disease resistance are also decisive factors in the improvement and selection of plant varieties. Thus, among scientists, the availability of healthy varieties with relevant or interesting properties is a key issue to be met at all costs.

In addition to their organoleptic characteristics, encouraging varieties are those with rapid growth, fast canopy production for good weed control, early tuber formation for good yields before attacks occur, and low disease susceptibility and low cultural requirements.

Future researchers will be asked to extend their analyses to more than two varieties or, if necessary, to all fifteen varieties found in the Democratic Republic of Congo.

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