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Suitability of Different Processing Techniques and Sales Options for Irish Potato (*Solanum Tuberusum*) Cultivars in Cameroon

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Executive summary

The Program of Accompanying Agricultural Research for Innovation (PARI) supports research activities to generate knowledge that informs the direction of investment and other action for innovation. Its work is expected to support the improvement of food and nutrition security and sustainable agricultural value chains in the Green Innovation Centres (GIC) in eleven African countries and India. This report presents the outcome of an original study on the suitability of potato varieties to processing techniques and a market prospection study on the possibility of introducing potato varieties into different market niches. It also analysed the best storage options for potato tubers at farmers' and vendors' levels; and another market prospection study to highlight the opportunities and constraints that may contribute to the sales of the potato product. Activity 1 investigated the suitability of potato varieties (Cipira, Jacob2005, Mumbi, Banso, Belo, Mondial and Dosa) to processing techniques. The study was conducted in Yaounde using available cultivars in *the* basins of Cameroon (North West, West, Adamawa, and Far North regions). The evaluation of potato processing techniques include the measurements of external parameters (tuber size, shape, eye-depth, number of eyes), internal parameters (Dry matter (total solids), moisture content, soluble solids, pH, titratable acidity) and sensory properties (colour, texture, flavour and overall acceptability) and percentage peel loss during processing. The assessment revealed that, the quality of potato tuber affects its aptness for processing and appreciation of its products by consumers. The most desired processed forms are the boiled tubers and fries. Cipira had the highest dry matter content (26.45%). While Cipira and Mumbi were most ideal for fries with respect to size; Banso and Belo were ideal for crisps. On the other hand, Dosa and Jacob were better suited for mashing and roasting while tubers of Mondial were suitable for boiling and more appropriate to be consumed in the form of salads. The best overall acceptability of potato fries and boiled potatoes was recorded for products made with Cipira, Banso and Mumbi varieties. Each of these varieties is therefore, of importance as its cultivation can target a processing technique.

Study two covered a market prospection for possible introduction of potato varieties into different market niches. The inventory helped to identify the various forms in which these products appear in markets, restaurants and supermarkets. Results of market analysis show that Irish potato is most consumed in the form of fries, mostly on the roadsides (*tourne-dos*) and in African restaurants for an average price of 1200 FCFA. Irish potato production and consumption were found to constitute a high-income generation activity in Cameroon, especially in the cities. The study on household consumers' awareness and behaviour towards Irish potato purchase and consumption sampled educated families, who attained at least high school level. An assessment of Irish potato acquisition mechanisms for people from producing and non-producing areas showed that majority of households that had an Irish potato farm were from potato production zones who received it through gifts from their home villages. Another means of acquisition is through purchases on the spot (cash markets), with more households from non-producing areas buying potato weekly, and those from production zones do purchase their potato from wholesale suppliers. People from producing areas could easily distinguish better varieties using characteristics like colour and flesh texture. This shows that social relationship is important in potato acquisition in the

households from producers. Diversities of potato processing techniques were observed in the production area, prominent meals prepared from Irish potato included potato hotpot, fried (chips), boiled, porridge, pounded, mashed potato balls and Salad. Therefore, dishes vary and people from non-producing areas are already adopting and eating some new potato dishes. Of the sampled meals, it was observed that potato traditional meals in the form of pounded potato, and porridge were mostly prepared by households from producing areas. Thus, the predisposition of tradition food systems and preferences stimulates people to consume specific. Our study showed that information's on potato production, and consumptions are shared within the social links.

Study three focused on the characterization Irish potato tuber and the analysis of best storage and transformation options. The result suggested that the crop was less cultivated in the Adamawa Region (0.25 to 1 ha). The main varieties produced are Cardinal, Bafoussam, Dosa, Panamera and Cipira though most consumers (37.93% respondents). Potato processors are mostly youths (66.66%) and the activity is mainly carried out by women (61.54%). Reasons that guide the choices of consumers are the starch content (56.52%), taste (52.17%), tuber size (17.39%), availability (13.04%) and colour (13.04%). Physicochemical analysis showed that diameter and length of Panamera were respectively higher (51.45 mm and 67.9 mm) than the other cultivars. Dry matter varied between 19.70 and 29.88% and Dosa had the highest dry matter (29.88%) and is best suitable for frying. Moreover, Cipira and Bafoussam seemed to be best for the other preparation processes. Sensory analysis of chips also revealed Cipira as the best. Hence, our study suggests that this variety is the most appreciated by consumers. In Yaounde, a study on the trends of Irish potato supply and out-of-home consumption of different potato recipes was realized. Results reveal that all classes of the urban population (from potato production zones or not) are more and more consuming potatoes out of home, especially for members from homes where there is not enough time to prepare food for many. Motivations for out-of-home potato consumption are cultural habits or interactions, low-cost and availability of a variety of potato meals in restaurants.

Study four was on market prospection to highlight the opportunities and constraints that may favour or hinder the sales of Irish potato derived products. This was also aimed at complementing the ongoing GIZ/GIC project on potato value chain development in view to guarantee future perspectives and potential collaboration with GIZ/GIC projects, which are currently focusing on introducing and valorising high-yielding varieties and seed multiplication. Our findings show that this activity will inevitably increase the quantity and sales of potatoes that will be available in the markets in the coming years, thus creating income for women and men alike. Sales points were of all levels and standards, meaning that potato is highly consumed in urban areas of Cameroon. Therefore, potato transformation and marketing could serve as a job creation and incoming generation activity for youths in Cameroon.

Introduction

Background to potato (*Solanum tuberosum* L.) production, processing and consumption in Cameroon

Potato is a widely used and appreciated food in the world. Irish potato tubers are obtained from *Solanum tuberosum* L. (described in 1753 by Linnaeus) which is a dicotyledonous tuberous herbaceous plant, perennial by its tubers in the absence of frost but grown as an annual plant. It is used for human consumption, animal feed, and as a source of starch and alcohol (Horton, 1997). Potato is the third most consumed crop by Man worldwide, with rice and wheat being at the top. It originated in South America. In the 16th century, in search of treasures and of the country Eldorado, the Spanish conquerors discovered potatoes in the indigenes' native soups. Potato was introduced in Europe in 1570 via Germany where it was known from the mid-17th century. At the beginning of the 18th century, the crop was introduced in North America and the development of its cultivation in France was stimulated by the permanent crisis and the devastating wars of 1750 and 1770. It was introduced into Africa at the end of the 17th century by the Christian missionaries in the form of small plantations. Like that of Europe, its production could contribute in the fight against food insecurity in the sahelian countries (Rousselle *et al*., 1996). It is characterized with flowery plants, and shares the genus' *Solanum* with at least 2000 other species, among which are tomato, garden egg, tobacco and pepper. FAO (2008) estimated world potato production at about 320,711,961 tons per year, for a total surface area of 19,264,021 ha. In 2011, potato production was observed to rise by close to 12 000 kilos each second (meter), hence 374 million tons. China is the world-leading potato producer followed by Russia and India (planetoscope.com; FAO, 2008). According to FAO (2008), the main producers in order of importance are China (72 040 000 tons), Russia (36 784 200 tons), India (26 280 000), United States (20 373 267 tons), Ukraine (19 102 300 tons), Poland (11 643 769 tons), Germany (11 604 500 tons), Belarus (8 743 976 tons), Netherlands (7 200 000 tons), and France (6 271 000 tons).

Cultivated potato varieties are numerous, in the order of many thousands and adapted to diverse ecologies, ways of utilisation, human consumption or industrial transformation. It's reproduction being done vegetative by planting the tubers, these varieties consist of clones that enable an indefinite reproduction to produce identical individuals. Meanwhile, this type of reproduction does not permit the elimination of viruses. The International Potato Centre where the most important gene bank for cultivated and wild potato species is found publishes each year a « world potato variety catalogue», and the last edition (2009/2010) comprises more than 4500 cultivated varieties in about a hundred countries. Potato was introduced to Cameroon during the colonial period (1884-1914). Soon after its introduction, potatoes quickly became part of the feeding habits of both rural and urban populations in Cameroon where the different varieties can be classified into 3 main classes: the improved varieties, the imported (European) varieties and the local varieties (CIP, 2009). In Cameroon, there are currently different potato varieties characterized by diverse forms, height and colour. They include: Cipra, Tubira, Bambui Wanda, Desiree, Cardinal, Banso, Mondial, Spunta and Diamant (Ntam *et al*., 2016). The certified varieties include: Cipra, Tubira, Bambui Wanda, Jacob and Maffo (IRAD, 2005). Since 2012, major projects like PNDRT, GIC, C2D/IRAD has

focused on boosting Irish potato production by selecting, multiplying and/or importing many tons of seeds. During 2014 – 2017, C2D/IRAD potato project multiplied and distributed 110 tons of potato seeds of improved and local varieties. In addition, during 2017, the GIZ ProCISA project donated 24 tons of Class E potato basic seeds to seed multipliers in the West, Nord-West and Adamaoua regions of Cameroon. A further 30 tons of class Basic seeds of the variety JELLY, MARABEL, BAVAPOM, SEVIM, KRONE and JUWEL all imported from Germany, were distributed to seed multipliers in Cameroon. As well, during this same period, the Ministry of Agriculture and Rural Development (MINADER) donated 150 tons of Mondial and Panamera potato seeds imported from Holland to farmers in these main production basins. This is an opportunity to increase the food base and reduce famine and poverty.

After FAO declared 2008 as a celebration of the International Potato Year, Cameroon has matured a program to reduce the production deficit. In August 2015, Yaouba Abdoulaye in his capacity as Minister Delegate to the Cameroonian Ministry of Economy, officially launched an agropolis for the production, marketing and processing of potatoes in Mbouda located in the Western region. Moreover, IRAD in collaboration with the International Potato Centre (CIP) released several improved potato varieties, two of which (Cipira and Tubira) have been widely adopted by the Cameroonian public for their high yields and resistance to late blight (Deffo and Demo, 2003; Njualem et al., 1998), adding to local varieties and imported varieties that are cultivated by farmers. The administrative regions of West, Adamawa, Far North, South West, Littoral, Central, North West and East have ecologically suitable areas for potato cultivation. Its world production amounted to 385 million tons in 2014 (FAO, 2014), making it the fifth largest crop after sugar cane, maize, rice and wheat. Its nutritional qualities and ease of cultivation have made it one of humanity's staple foods, among the most widely consumed vegetables and starches. Apart from sugar cane, it is also the most productive food crop, producing more dry matter per hectare than cereals and any other cultivated plant (INSEE, 2009). Potato is among the major agricultural crops that are consumed by a large number of people from different countries. It is processed industrially to a number of ready to eat product types (Alessandrini et al., 2010). It contributes to almost 50% of the total tuber and root crop production. Since the early 1960s, the growth in surface area for potato production has rapidly overtaken all other food crops in developing countries and potato has become a fundamental element in food security for millions of people across South America, Africa, and Asia, including Central Asia (CIP, 1999).

Project objectives

Potato is one of the main sources of revenue for farmers in regions where it is grown in Cameroon. It accounts for 80% of Cameroon’s national production (Fontem et al., 2004) and is now considered as a cash-food crop with an annual tonnage of over 250,000 tons, grown on over 70 000 hectares (FAOSAT, 2014). The main production basins in Cameroon are the highland areas (North West, West, Adamawa, and Far North) where close to ten potato varieties are produced all year-round. To increase production in Cameroon, much research has been carried out on the adaptability of various potato varieties to the different agro-ecological zones and pathological conditions. Potato has a high nutritive value. It is an important source of carbohydrates, protein, minerals like calcium, potassium and vitamins like vitamin C. Potato has a high nutritive value and the ratio of protein to carbohydrates is

higher than that of most other food crops (Schippers, 1998). The “nutritional productivity” of potato is especially high: for every cubic meter of water applied, 5,600 calories of dietary energy are produced, compared to 3,860, 2,300 and 2,000 in wheat, rice and maize respectively. For the same cubic meter, potato yields 150 g of protein; double that of wheat and maize, and 540 mg of calcium, double that of wheat and four times that of rice (Nteranya, 2015). It is used for human consumption, animal feed, and as a source of starch and alcohol (Horton, 1997). Its role in the market economy in Cameroon has increased, due to demand from neighbouring countries such as Gabon, Central African Republic and Equatorial Guinea (Aquah et al., 1994). It can significantly contribute to reducing food insecurity source of income, alleviate poverty and create employment opportunities in Cameroon. However, inadequate attention is given to postharvest processes (storage, packaging, processing, marketing and consumption). The consumption and scale of valorisation of this crop limited in Cameroon. This lowers its potential to contribute significantly to national food security and economic development. Investigating the suitability of various potato varieties from the main production basins (North West, West, Adamawa, and Far North) to different processing forms and marketing options may lead to increased consumption and revenue to producing households while creating jobs and new markets for urban poor and enhancing food security. Being a short cycle crop, developing and valorising suitable potato processing techniques per variety from each production basin could boost up palatability and hence consumption and sales of potatoes and therefore help in addressing problems of malnutrition and poverty in Cameroon and especially in the extreme north area faced with problems of conflict, extreme environmental degradation conditions, land and water scarcity. Consequently, the overall objective of this work was to explore the market/procurement and recipes, for potatoes processing techniques that boost up the palatability, consumption and sales of potato products in order to reduce food insecurity and/or increase sales options for increase revenue. Investigations focused on the suitability of potato varieties grown in the main production basins in Cameroon to different processing techniques and sales options. Specific objectives were to:

- investigate the suitability of different potato varieties grown in the main production basins in Cameroon to various processing techniques, in order to identify their best forms of consumption and potential industrial use;
- Did a market prospection study on the possibility of introducing potato varieties based on processing forms and processed products into different market niches;
- analyse household consumers’ awareness, perceptions, attitudes and behaviour towards Irish potato procurement and consumption;
- determine the varietal characteristics, conservation and transformation processes of Irish potato in the Adamawa region of Cameroun;
- analyse the procurement and consumption systems of potato dishes prepared out of home in big cities like Yaounde;
- enhance household and outdoor potato consumption through the conception of a recipes book of potato dishes from the Cameroonian cuisine.

Six main activities aimed at addressing the objectives cited above were carried out between the 15th of April 2017 and 31st of December 2017. The methodology and results obtained for

each of the activities are presented in the sections that follow. Apart from the book of recipes, each chapter of this report has been further developed to constitute a research paper, all of which are in press for review and publication in peer reviewed scientific journals (see titles of articles in the appendix).

The first part of this report provides the research output concerning the assessment of the suitability of potato to various processing techniques. Irish potato (Solanum tuberosum, L.) happens to be the most important food crop in the world after wheat, rice and maize (FAO, 2008). Much of the potatoes produced in the Eastern and Central African Countries are mainly consumed fresh. Like other root and tuber crops, this crop is bulky and perishable (Scott et al., 2000). With population doubling every 25 years and urbanization continuing to increase by 1.3 percent yearly, feeding habits will continue to change in favour of easy-to-prepare foods (Abass et al., 2014) and processing has the potential of enabling potato to take the status of an industrial crop similar to that of maize and wheat. This would help to create more employment, improve nutrition and enhance incomes of potato farmers. The suitability of potato tubers to processing depends on tuber quality which includes both internal and external parameters (Alessandrini et al., 2010; Kabira and Lemanga, 2003). The external parameters include: the appearance (size, shape and eye-depth) and defects on the skin, which influence wastage during processing while internal parameters include: dry matter, reducing sugar content, and discoloration in cut tubers and processed tubers. These parameters will greatly influence the profitability and consumer preference of processed products. Other factors that may interfere in a negative and/or indirect way on the technological quality of tubers are pulp pH, total acidity, and starch content. The pH index determines deterioration potential by fermentation and the activity of enzymes, whereas starch which constitutes the greater part of the dry matter has an influence on the texture of the processed product. Feltran et al. (2004) showed that technological parameters of potato are influenced by genotype or cultivar.

The potato varieties in Cameroon can be classified into 3 main classes: the improved varieties, the imported (European) varieties and the local varieties (CIP, 2009). The Institute of Agricultural Research for development (IRAD) in collaboration with the International Potato Centre (CIP) released several improved potato varieties, two of which (Cipira and Tubira) have been widely adopted by the Cameroonian public for their high yields and resistance to late blight (Deffo and Demo, 2003; Njualem et al., 1998). The local and imported varieties are also cultivated by farmers in Cameroon. The quality of potato tuber affects its aptness for processing and preference of its products by consumers. The objective of this activity was therefore to evaluate the suitability of potato (*Solanum tuberusum*) varieties grown in Cameroon to processing techniques, in order to identify their best forms of transformation, sales and consumption. Seven potato varieties (Cipira, Jacob2005, mumbi, Banso, Belo, Mondial and Dosa) grown in the North West Region of Cameroon and harvested at full maturity were evaluated with respect to external parameters (tuber size, shape, eye-depth, number of eyes), internal parameters (dry matter (total solids), Moisture content, soluble solids, pH, titratable acidity) and sensory properties (colour, texture, flavour and overall acceptability) of boiled tubers as well as potato fries. The percentage peel loss during processing was also evaluated. This activity involved investigations on the suitability of

different potato varieties to various processing techniques such as hotpot/boiled and pounded potatoes for local food vendors, potato chips, frozen potato for French fries, potato flakes and potato flour.

The second activity dwelled on a market prospection study to introduce potato varieties into market niches. A market prospection study is the preparation, collection, analysis and exploitation of data and information related to a marketing situation (Kotler et al., 2009). Marketing is the main concern to meet the demand to achieve optimum sustainable profit (Vandercammen and Gauthy-Sinéchal, 2014). As a matter of fact, Sub-Saharan Africa, with a population growth rate of over 2% per year in several countries, is willing to diversify its diets and distribution system of agricultural products, experimenting pressure on production and use of food (Scott, Labarta and Suarez, 2013) more than anywhere else in the world. Moreover, food security hosted by the supply of urban growth markets and other city expansion are major axes of developing the agricultural and food sectors (Hall et al., 2014) In which potato is proving to be a strategic issue in food security. The cultivation of potato is therefore a strength and an opportunity to grab that is relative through threats and weaknesses including lack of technology use, rural development priority (Rana et al., 2017). The potato market is rightly described as bright with several actors working to develop its value chain (Margolies and Buckingam, 2013; Mudege, Mayanja and Muzhing, 2017; Temgoua et al. 2014; Mutunga, 2014). Given that its contribution to food security can be taken for granted, it is important to focus on its economic potential (Kometa and Yiven, 2017; Bonabana-Wabbi et al., 2013; Ugonna, Jolaoso and Onwualu, 2013; Reyes et al, 2012). Economic potential is anchored around value. In fact, a product knows success only if it provides value and satisfaction to its buyers (Kotler et al., 2009). This value reflects the relationship between the expected benefits and the tangible and intangible costs perceived by customers; and the satisfaction corresponding to the judgment of an individual who during consumption, compares the perceived performance of a product / service with his previous expectations. Value can be created through processing and marketing of a product and it can be captured through market research via the mix-marketing.

The objective of this activity was to examine the potential of food processing and marketing of potato varieties cultivated in Cameroon, and to assess the ways of valorising and promoting potato products and ensuring their contribution to food security, creating direct and indirect jobs and providing a source of income for the population (Nguyen, 1970). This potential covers the different storage and transformation technologies known and used; and finally, the economic potential of potato grown in Cameroon. Mix-marketing which is the set of instruments within the reach of a company to achieve its objectives in the target market (Kotler et al., 2009) was used for this survey. These are various levers of action grouped around the "4 P" which are: price, place, product and promotion (Figure 1) in order to reach a target market. Based on the foregoing, this study proposes to answer the following research questions: What is the main form of potato preparation in catering establishments? What knowledge do transformers have about potato varieties and their perception of their social status? What is the satisfaction of the potato processing activity?

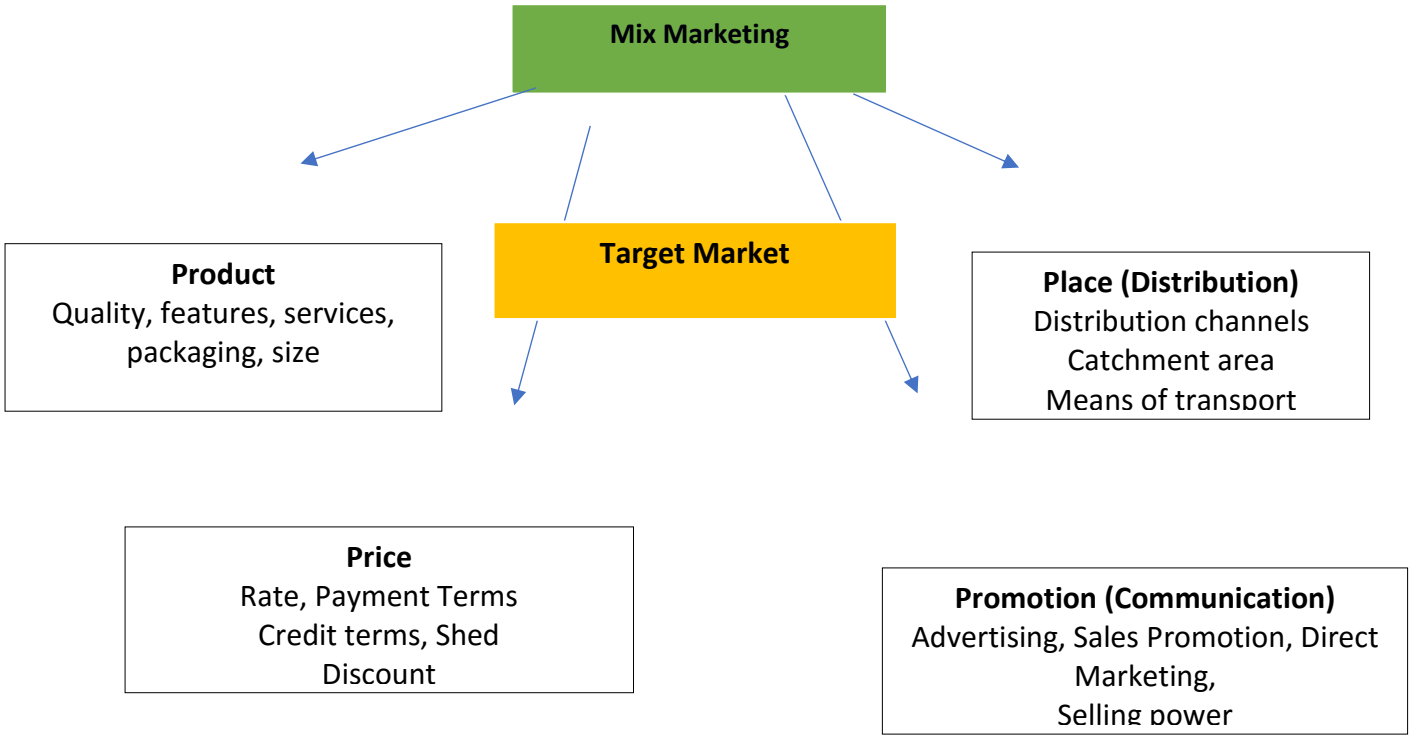


Figure 1: The four components of mix-marketing

The third aspect of this research analysed consumers' awareness, perceptions and attitudes towards Irish potato procurement and consumption. This was based on the fact that food insecurity and undernourishment can be caused by the unavailability of food, insufficient purchasing power, inappropriate distribution, tribal or cultural background or inadequate use of food at the household level (Alfa et al., 2012; Maren et al., 2008; Sopca et al., 2008). In Cameroon, for instance, there is a tribal distribution of staple and other foods and the dietary diversification index is very low, as starchy foods provide almost three quarters of the total energy supply (Sopca et al., 2008; WFP et al., 2011). A study on determinants of urban plantain consumption in Cameroon showed that there are many different ways of cooking plantains due to many ethnic groups and their diversification ideas (Dury et al., 2002). The predisposition of traditional food systems and preferences as well as the lack of food that is culturally acceptable, affordable, and nutritious can lead to hunger and undernourishment in the case that a population do not have access to the food that is traditionally known and acceptable (Haasova et al., 2016). Changing people's behaviours on food depend on how food is accessed, cooked and consumed at household level (Dury et al., 2002). Thus, an important step to reduce hunger and undernourishment in poor regions will be to seek strategies of introducing and diversifying the dietary practices of these people. One way will be to discover new foods and make them culturally and traditionally acceptable following local tastes and preferences. In this context, Irish potato can play an important role. As mentioned earlier the main production basins of Irish potato in Cameroon are the North West, West, Adamawa, and Far North regions with the Northwest and West regions being the chief areas of production and most culturally diversified. However, people around the Banso area in the Northwest region eat more of cereals and vegetables (pastes from corn, Irish

potato etc). In the Santa-Akum area, there are people who consume more of roots and tubers although they produce lots of Irish potato. On their part in the West region, the Bamilekes consume more of banana and potato while the Bamouns consume more cereals in the form of maize flour.

This study was designed to measure the effects of peoples' origin and acculturation on Irish potato procurement and consumption in urban areas in Cameroon taking the case of Yaounde city. Cameroon's urban areas especially Yaounde, the capital city, are rapidly growing and there is need to stimulate the intake of new foods. However, culinary procedures related to potato preparation are limited and some people simply stick to their traditional taste and preferences. Although potato is consumed by households in producing areas in various forms, for houses from non-producing areas, potato dishes are unusual in their dietary patterns (Ugonna et al., 2011). Also, when people change locality, their dietary patterns are modified by their new environment and interaction with other people. Exposure and acculturation has been noted to have both beneficial and deleterious changes in dietary habits, especially among groups living in urban areas (Alfa et al., 2012). This has been greatly analysed in the case of dietary habits and food intake patterns in the USA (Batis et al., 2000; Duffey et al., 2008; Dixon et al., 2000; Aldrich and Variyam, 2000). Urban Cameroon like most African cities are undergoing a "nutrition transition" in which people tend to consume foods that originate from other places (Alfa et al., 2012). Thus, as a means to curb down urban food insecurity, it is necessary to identify strategies of introducing and diversifying the dietary practices of Cameroonians especially those in urban areas who may not have access to traditional foods. The aim of this activity was to reduce food insecurity and hunger especially in urban areas of Cameroon, by increasing the intake of Irish potato in all its forms. Factors that motivate urban households to consume Irish potato were analysed, with suggestions on ways of incorporating Irish potato dishes into the dietary base of people from all regions and cultural groups in Cameroon. We also identified sources of Irish potato acquisition for urban dwellers, main meals prepared and preferred characteristics.

This project also captured concerns on varietal characteristics, conservation and transformation processes of Irish potato in the Adamawa region of Cameroun. Records hold that there exist several potato varieties, some of which are purple in colour, due principally to the presence of anthocyanin (Liu, 2014). Others are red in colour (Peksa, 2013) while some are white or yellow (Lachman, 2013). Freshly dug potatoes contain 78% water, 18% starch, 2.2% peptides, 1% mineral salts and 0.1% lipids. Potato is an important source of starch to produce adhesives and alcohol. The behaviour of the various components during the preparatory and cooking phase has a major impact on the taste and flavour of potatoes (Descours, 2013). The Adamawa and other Regions of Cameroon constitute favourable ecosystems for the cultivation of potatoes. However, as is the case for the entire territory, the valorisation of important national production is still limited, emphasis not yet being placed on the post-harvest technologies and marketing of this commodity. The objective of this activity was to study the various potato varieties produced in the Adamawa Region. Specifically, the study aimed at identifying the various potato varieties, their modes of conservation, transformation, commercialization and consumption; doing a physico-chemical

characterization of fresh potato tubers; studying the conservation techniques of fresh peeled potatoes; doing a case study on a transformation technique, that of potato chips production.

Potatoes harvested at full maturity can be conserved for 10-12 months. The question of storage arises for the so-called «conservation potatoes» as well as those destined for industrial transformation and for sowing. The live tubers with high levels of water undergo the phenomena of respiration and transpiration. They are also subjected to weight loss with time, wilting and development of germs. They can equally be exposed to risks of fermentation and attack by bacteria and fungi. They must be preserved from freezing. The storage conditions to be respected include the following: darkness, ventilation, controlled humidity, temperatures maintained between 4 and 6°C. Anti-germination treatments are authorized during storage with the aid of substances such as prophame or chlorophame either by dusting or by fogging, with the latter ensuring a better distribution of the product and preventing the risk of localized overdose, or by ionization. The consumer can conserve potatoes for several weeks, depending on the variety, in a cool room sheltered from light. The so-called «consumption potatoes» harvested before complete maturity can only be conserved for a few days. Potato has four utilization types: human consumption (in the form of fresh tubers or transformed), animal nutrition, industrial extraction of starch and other by-products, crop production. With respect to type of preparation, the transformed products can be classified under three main categories: (i) Canned products, sterilized in jars, boxes or plastic bags; (ii) Dehydrated products (powders and flakes) destined for the preparation of reconstituted purées or used for the manufacture of soups, snacks; (iii) Fried products, chips, fresh or frozen fries, straw potatoes. There equally exist some products such as the gratins, the patties, the dauphine potatoes etc. In the fresh market, consumer requirements focus on the quality of presentation as well as the defined quality criteria (culinary properties) depending on the uses. As for the transformation industries, the requirements in terms of quality are economic and technological requirements. One of the most important criteria for quality control is the dry matter content of the tubers. A high dry matter content (between 20 and 25%) increases the industrial yield in finished products (flakes, chips and fries), improves the crisp of the fries and the consistency of the purées, reduces oil retention of the fried products (chips and fries) (Arvalis-infos.fr). Potato tubers equally intervene in animal nutrition, starch production, production of ethanol biofuel, production of glycocaloids, the use of the peelings to cover the silage silos corridors (Fauconnier and Delaplace, 2004). In this study, different varieties were effectively identified, and the storage and physico-chemical characteristics of fresh tubers determined. A case study of transformation (chips) was also assessed.

Finally, an analysis of supply and distribution systems of food prepared out of the home in big cities was done, taking the case of potato in Yaounde. In this regard, under-nutrition remains a major concern in many African countries. Thus, food sovereignty requires a contextualization of the issue. Indeed, it is clearly linked to the environment, social, cultural and legal rights of each country but also to economic policies (global and national) and natural conditions. However, the different access routes to prepared food remain very weak or non-existent on the one hand, or less popularized on the other hand. The environment and accessibility to food play a key role in the choice of human food. Urbanization leads to a change in dietary habits, westernization of diets, sedentarization and changes in lifestyles in

general (Becquey et al., 2010). Urban dwellers in developing countries will more than double between 2000 and 2025 (Becquey et al., 2010; FAO et al., 2017). This rapid urbanization is accompanied by a change in feeding habits: more meat, fat, salt and sweet products, meals bought outside the home (Becquey et al., 2010; Akoa et al., 2017) which explains the presence of ready-made food supply points to facilitate rapid consumption (Restaurant, “tourne- dos”, etc.). Indeed, due to the lack of adequate means of transport and time, many workers, students, school children, etc., cannot return home for meals. The increasing demand for street food is also due to migration phenomena that lead to an increase in the number of people living alone, often in difficult circumstances and with low incomes (FAO, 1997). Considering that the agri-food sector in sub-Saharan Africa is characterized by significant post-harvest losses and low level of processing of agricultural products (French Development Agency, 2016), eating meals in the streets, in the morning or at noon, is becoming a common attitude in Africa. The role of the street food sector in the urbanization process and in the functioning of the urban economy reflects the way of life and survival in African cities (FAO, 1997). If the sector in Cameroon is maintaining itself but continues to develop in the cities, it is precisely because it meets the strong demand of the populations, satisfied thanks either to the proximity of the workplace, or to the cultural dishes offered, or to the affordable prices of marketed products such as potatoes, with very few quality and health requirements.

The attractiveness of "ready-to-eat" food is linked to conservation equipment, lifestyles and group purchases in supermarkets (INSEE, 2009). Potato starch gave birth to a processing industry with multiple outlets in the agri-food, cosmetics, pharmaceutical and industrial sectors (1884-1914). In addition to a collective, societal approach, food sovereignty requires that it be addressed at the individual level, in relation to the vulnerability of individuals and the social networks into which they may or may not integrate (Charlier and Warnotte, 2007). Speaking of distribution, catering, which is a relay tool in urban areas in Africa, is popularized and most of these restaurants remain informal activities due to poverty in urban areas. The informal food sector has been defined as "the sector producing food and beverages ready for consumption, prepared and/or sold by vendors, especially on the streets and in other similar public places" (FAO, 1990). However, it is particularly important in African urban centres where rapid urbanization and economic difficulties have led to an increase in the number of food vendors. This sector provides urban populations with ready-to-eat foods that taste popular and are affordable. Households are spending less and less time preparing their meals (Bricas and CIRAD-SAR, 1991). Expenditure data reveals that processed products (from slightly processed to ready-to-eat) account for a significant share of expenditure and that for some categories this share is increasing (Winandy et al., 2012). We also noticed that meals taken outside the home are an alternative that is increasingly adopted by households. The complete prepared dish represents the ultimate stage of food processing and saves considerable time for some, but is a way to consume foods that are difficult to cook in the household. The objective of this study was to highlight the potato products available on markets and commercial spaces, the dishes most consumed by consumers outside households, analyse the qualities/characteristics of processed potato products sought by consumers outside households in order to find the potentialities to popularize the marketing of new potato dishes.

The methodologies applied to achieve the objectives of the project are presented in the next section.

Methodology

Study Area

This study was executed in all the potato producing areas of Cameroon covering Northwest, West, Adamawa and a major consumption pool which in Yaounde. Since the focus was on post-harvest processes, the bulk of the activities were concentrated in Yaounde- a cosmopolitan city with Adamawa and Northwest serving mainly as the zones where raw material was collected for quality and sensory analysis. Yaounde as the capital city of Cameroon is located on latitude 3.87 and longitude 11.52 and is situated at 726 meters above sea level. It has an area of 180 km² and a population of approximately 2.5 million as of the 2010 census making it the biggest city in the centre region and the second largest city in the country. It has tropical climate and two seasons: the rainy and dry seasons. Relative humidity can be as high as 95 %. The land is made up of predominantly tropical soil. Yaounde economy is centred on the administrative structure of the civil service and the diplomatic services. Yaounde was chosen due to these high-profile central structures and the relatively higher standard of living and security compared to the rest of Cameroon meaning it is easy to evaluate variations in the use of food based on economic, cultural and other factors. Before engaging in all the studies, an inventory of all the subdivisions and neighbourhoods in Yaounde was made to understand the most hot spots and the use of potato food in and out of households. Figure two presents a map of Yaounde with its seven subdivisions.

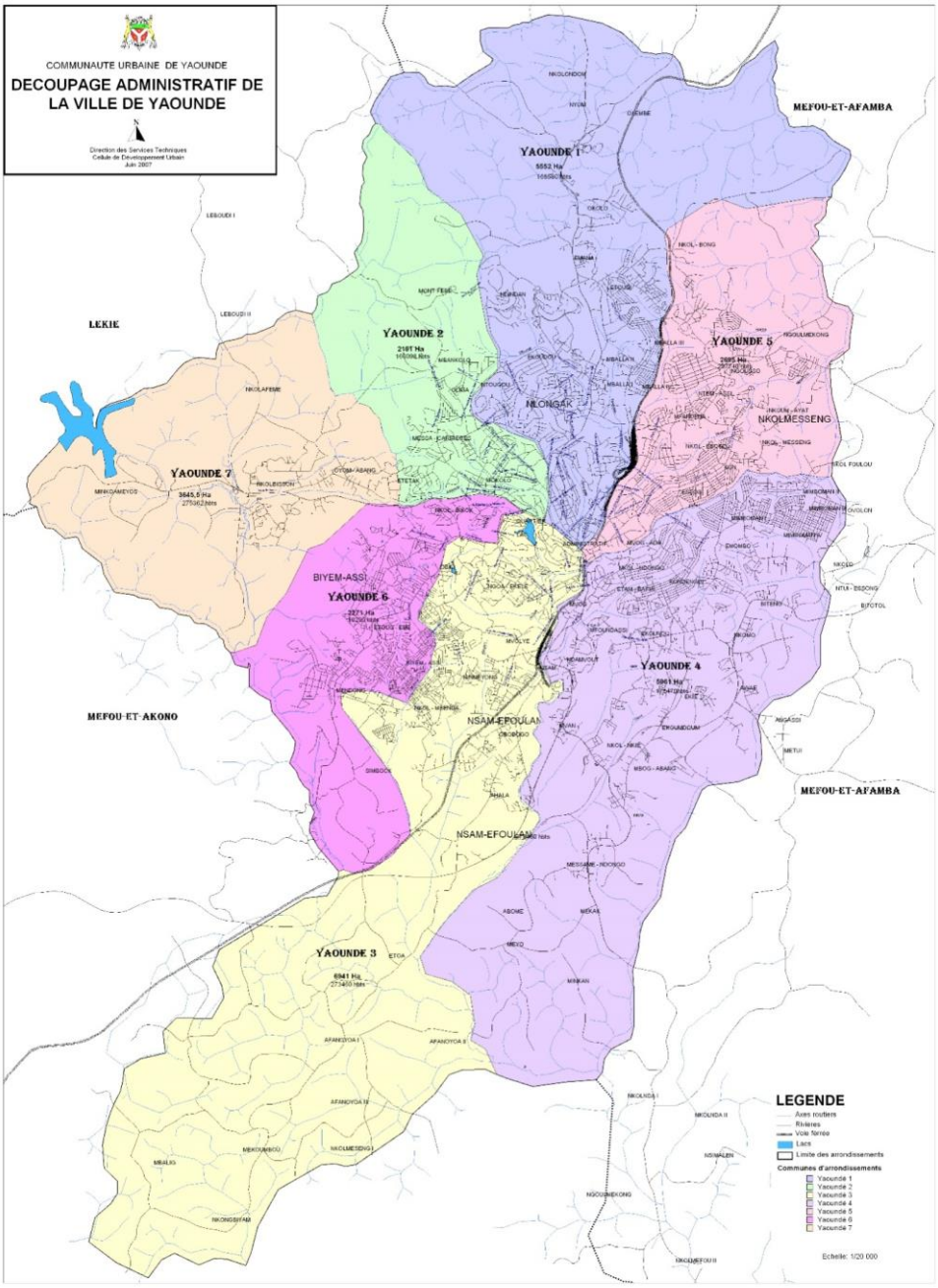


Figure 2: Map of Yaounde and its sub divisions

Methods for the assessment of the suitability of potato to various processing techniques

For the technological quality study, potato varieties were obtained from farmers of the Santa Municipality (05°51.382' N; 010°10.500' E) in Mezam Division, North West Region of Cameroon. The Santa locality has an average annual rainfall of 2135mm and an average temperature of 18.8°C with penevoluted ferralitic and Aliatic soils. Agriculture is one of the important economic activities of this locality with potatoes, cabbage, carrot, green beans, tomatoes and green spices being common agricultural produce of the municipality. The potato tubers harvested at full maturity in the month of January 2018 were bought from

farmers and transported in bags to the Food Technology and Post-Harvest Laboratory, IRAD Bambui for quality evaluation. Based on the availability of varieties during the research period, a sample of each variety was obtained from two or more farmers. The varieties used for the study are shown in Table 1 and Figure 3.

Table 1: Varieties collected

No.	Name of Variety	Class of Variety
1	Cipira	Improved (IRAD)
2	Jacob 2005	Improved (IRAD)
3	Mumbi or Dschang	Local
4	Banso	Local
5	Belo	Local
6	Mondial	Imported
7	Dosa	Imported

Figure 3: Potato varieties studied

For the sensory evaluation part of this study, assessment was carried out with 15 participants – 5 men, 5 women and 5 children below 10 years for 3 - 5 processing techniques in Yaounde using potato varieties from four agro ecological regions - the main production basins of potatoes in Cameroon (North West, West, Adamawa, and Far North regions). The sensory evaluation focused on boiled potatoes and potato fries which were prepared as indicated in Figure 4.

Tuber size measurement

Sample preparation for dry matter

Titratable acidity

Browning of cut tuber

Peeling of tubers

Slicing of potatoes for fries

Figure 4: Steps in the preparation of samples for sensory analysis

Each potato variety was washed several times with potable water and the quantity to be used weighed (W0). It was then finely peeled using a potato peeler or a sharp knife and the weight

(W1) of the peels recorded and the losses incurred at this stage of processing determine. The products for evaluation were then processed following the process into potato chips and boiled potatoes followed by sensory evaluation using a 9-point hedonic scale with categories from like extremely good (9) to dislike extremely (1) as shown in Table 2.

Table 2: Sensory evaluation of fried and boiled potato samples

Acceptability	Quality description	score
unacceptable	Extremely poor	1
	Very poor	2
Barely acceptable	poor	3
	Below fair/above poor	4
	Fair	5
Acceptable	Below good/above fair	6
	Good	7
	Very good	8
Highly acceptable	Extremely good	9

With this scale, the Colour, texture, flavor and overall acceptability of potato samples were evaluated by a panel of 15 persons. The panelists between 20 and 60 years of age are regular potato consumers and made up of researchers and technicians of both sexes of the IRAD Bambui Centre. The hot coded samples were separately served to panelists with potable water for rinsing of mouth between samples. Another activity was the determination of the technical quality of potato tubers. The technical quality of potato tubers refers to a number of features (external and internal) determining their suitability for processing (Lisinska et al., 2009). The external parameters include the tuber size, shape, eye-depth and number of eyes (buds) while the internal parameters include the Dry matter (total solids), Moisture content, soluble solids, pH, titratable acidity, flesh colour and time taken for darkening of cut tuber (enzymatic browning). For assessment of external parameters, twenty potato tubers per variety were randomly selected from the lot obtained from each farmer. The length of each tuber was measured from the apical end to the stolon end with the help of a Calliper, and the diameter (width) of the tuber was measured midway the length on a horizontal axis. Tuber shape was calculated by the relation I.V. = L/Wx100, where, I.V. is the index value of the tuber; L is the length of the tuber, and W is the width of the tuber. Tuber shape was determined by index value as round (<109), oval (130 to 149), long (170 to 199), short-oval (110 to 129) (Ekin, 2011). The eyes (buds) present on each of the tubers were counted, and the depth recorded as shallow or deep. The average length, diameter and eye number for each variety was then calculated and recorded.

The internal parameters of potato tubers take into consideration the chemical composition and features of the potato flesh. The following internal parameters were evaluated within this study. For dry matter and moisture content evaluation, a sample of 10 potato tubers each per variety was randomly selected from the lot, washed, finely peeled and sliced into small pieces. The dry matter and moisture content of each sample were determined according to AOAC (1990). Soluble solids (°Brix) were assessed as follows. The juice extracted from the pulp of grated potato tubers was used. Two droplets of juice at 20 °C were placed on the prism of

an Eclipse refractometer and the value read on the scale of the instrument and recorded. Two replicate per sample were performed. Pulp pH and titratable acidity were determined according to Feltran *et al.* (2004). A 50 g sample of potato flesh was ground with 100 mL distilled water. The pH reading was read with use of a digital pH-meter (HANNA pHep) and recorded. Titratable acidity, on the other hand, was determined by titrating the filtrate from 50 g of pulp (Vs) ground in 100 mL distilled water, with a 0.1M NaOH solution using phenolphthalein as the end point indicator. The titration was done in duplicate, and the average titre (V_{NaOH}) used in the calculation of titratable acidity (% malic per 100g of fresh tuber with milliequivalent of 0.067). Flesh colour and rate of enzymatic browning were also evaluated. The flesh colour was observed after cutting tubers into two. Ten tubers from each variety were observed by five researchers, and the colour recorded. The rate of enzymatic browning was determined by slicing tubers into two halves and the time taken for a prominent colour change registered.

Methods for the market prospection and consumer's awareness study

This study was executed in Yaoundé. With regards to the market prospection and consumer's awareness study, the aim was to determine the possibility of introducing potato varieties following their processing forms and these processed products into different market niches such as restaurants, road side/school premises food vendors and supermarkets. Here, a field inventory was done to identify the various forms in which these products appear in markets, restaurants and supermarkets. A second round of the survey was done to find our vendors/consumers impression about the products and perspectives for improvement. The Yaounde 1 and 2 subdivisions were chosen for questionnaires survey. Using a Likert Scale, vendors' impressions were appreciated on the possibility of introducing the processed forms of potato products in local markets. The secondary data came from the exploitation of scientific documents such as books, articles and scientific reports available in the library of the Institute of Agricultural Research for Development and on the Internet. Primary data were obtained after a structured approach. At first, an exploratory study was made in the city of Yaounde to identify potato-based product's transformers. For this purpose, non-probability sampling was carried out. It is a means of selecting units of a population using a subjective approach (Canada Statistics, 2010). The subjective method consisted in surveying the various subdivisions of the city of Yaounde (Table 3) in order to identify the various actors in the restaurant sector offering their customers potato-based dishes.

Table 3: Neighbourhoods per sub division in Mfoundi

Sub division	Neigbourhoods	Selected areas
Yaounde I	Bastos, Emana, Etoameki, Etoudi, Olembe, Mballa II, Nlongkak, EligEdzoa, Nkol- Eton, Centre Commercial	Bastos, Emana, Etoameki, Etoudi, Olembe, Mballa II, Nlongkak, EligEdzoa, Nkol- Eton, Centre Commercial
Yaounde II	Tsinga, Nkomkana, Messa, Madagascar, Briqueterie, Carrière, Cité Verte, Mokolo, Mbankolo	Tsinga, Nkomkana, Messa, Madagascar, Briqueterie, Carrière, Cité Verte, Mokolo, Mbankolo
Yaounde III	NgoaEkelle, Ahala, Nsimeyong, Obili, Nsam, Obobogo, Efoulan, Dakar, Olezoa, Mvolyé, AfanoYoa	None
Yaounde IV	Mimboman, Ndamvout, Nkoldongo, Awae, Nkomo, Ekounou, Ekié, Mvan, Kondengui, Odza, Messamendongo, Biteng, Ekoumdoum, Anguissa, Foundassi, Mvog- Ada	None
Yaounde V	Ngousso, Mfandena, Nkol-Ebogo, Essos, Nkol-Ebong, Mvog-Ebanda, Nkoumayat	None
Yaounde VI	Melen, Biyem-Assi, Mvog-Betsi, EligEffa, EtougEbe, Simbock, Nkolbikok, Mendong	None
Yaounde VII	Minkoameyos, Nkol-Afame, Oyom-Abang, Etetak, Nkolbisson	None

Source: From the 3rd General Population and Household Census (GPHC), Yaounde 7 Council, Cameroon

In a second phase, data collection continued through a questionnaire. This is a standardized instrument, applied in full by a repetitive procedure within the survey population. Moreover, it is likely to be analysed following a statistical analysis (Lacombe, 1997). The questionnaire is an extremely flexible tool for the different questions that can be asked (Kotler et al., 2009). The questions aim to analyse the processing and marketing of potato products within the target population. This is mainly to highlight the mix marketing and the socio-economic profile of the manager / processor manager; and categorize their customers. The final questionnaire was obtained after tests made in several stages. First, after designing the questionnaire, there was a test phase between the investigators to criticize the questionnaire and especially to ensure that they all have the same level of understanding the questionnaires. Finally, there is a simulation phase of questionnaire administration records, with some transformers identified through the exploratory survey. The purpose is to ensure that the questionnaire is understandable by the various operators in the catering sector and also to amend the questionnaire of sensitive and irrelevant questions in order to lighten the questionnaire as much as possible and to make it simple. It is only after this stage that the latter followed, namely the effective administration of questionnaires to targets. Thus, to carry out this study, the target population was defined through transformers (restaurant, hotel, rotisserie, spinner, etc.) and their customers with potato-based dishes. The quota method we have chosen for this survey is generally used in socio-economic surveys (market surveys, opinion polls, etc.). It assumes the correlation of different characters of the population (Grais, 2003). Here, the investigator has the opportunity to decide who is added to the sample. In the context of data collection, requested units that are not willing to participate are simply.

replaced by others that are, and non-response bias is, in fact, ignored (Statistics Canada, 2010).

Methods for the study on the analysis of consumers' awareness, perceptions and attitudes towards Irish potato procurement and consumption

The study area for the analysis of consumers' awareness, perceptions and attitudes towards Irish potato procurement and consumption was Yaounde which is a cosmopolitan with people from all parts of Cameroon. This study used a cross-sectional design (Setia, 2016) since it was aimed at providing a snapshot of characteristics of city dwellers regarding Irish potato use for household food consumption. The cross-sectional sample was drawn from urban households living in Yaounde, but originating from Irish potato producing and non-producing areas in Cameroon. For household sampling procedure, generally, people that originate from various parts of Cameroon while out of their villages, often group themselves into meetings and association. These social groups help people to continue to feel and share their cultural beliefs and meet people from their area even when out of the villages. This study used such settings for data collection. Therefore, meetings were the main units of identifying households for data collection. A multistage sampling technique (Sedgwick, 2015) was used to gather information from 180 households (Table 4) with the use of a structured questionnaire. The first stage was the purposive selection of Yaounde due to the availability of diverse groups of people. It was further used to select the various groups from which households were drawn from the interview to get representative groups from all the regions concerned. The second stage employed the use of systematic random sampling technique (Sedgwick, 2015) to select 15 households each from each association or meeting (Table 4). The main idea is that those from producing areas will naturally be consumers of Irish potato following tradition food consumption patterns and food availability concepts, while those from non-producing areas will be new consumers and therefore, will be adopting potato dishes into their diets through the impact of acculturation and exposure. Six samples were established for households from Irish potato producing areas taking into account sociocultural factors (ethnic groups, main traditional meals and ways of using Irish potato locally) that determine the nature of tradition food intake of these areas.

Table 4: Household sampling design for consumers awareness activity

Origin	Name of the Associations	Region in Cameroon	Age of association	Total number of membership	No. of households selected for the interviewed
Origin from Producing areas	ADJEMA	Adamawa	25 years	105	15
	Le Mayo-Tsanaga	Far North	20 years	109	15
	Femme Solidaire du Grand Noun	West	35 years	205	15
	Neighbours (Wum)	Northwest	18years	204	15
	Femme Entreprenante	West	22 years	304	15
	Akum Welfare Association	Northwest	30 years	305	15
Origin from Non-producing areas	REMARE	North	35 years	208	15
	Solidarité Sans Frontière	South	18 years	130	15
	Union des Femmes Chretienne Briquetterie	Centre	40 years	150	15
	Nkulnam	Littoral	25 years	50	15
	CAEBRI	East	15 years	65	15
	Ebamut Family Meeting	Southwest	16 years	89	15
	Total				180

All the other regions in which Irish potato was not produced were considered non-producing areas (Table 4). Village meetings were the main units of identifying households for data collection. In each case, a meeting was identified and 15 members were elected randomly. The social status of the elected members was considered; they were selected from across the social profiles. As well, we considered only village associations that were at least 10 years old since their creation. Also, members to be interviewed were those who have stayed in the association for at least two years meaning that they had experience with urban life and had stabilized their livelihoods and especially food procurement patterns. The primary data from the sampled households were collected through a formal surveys by using a structured questionnaire. The questionnaire was pre-tested before the main survey to check the relevance of questions and to determine whether it was comprehensive enough to collect the required information. The information collected included household general characteristics,

household source of income, and Irish potato consumption, including quantity consumed, sources of Irish potato and price per unit, different methods of cooking Irish potato and problems faced with Irish potato storage, processing and consumption as well as proposed solutions. The researchers did the interviews and provided guidance and technical support during the exercise. Field errors were corrected while in the field and data, completeness was checked on a daily basis on all the questionnaires that were submitted by the various researchers from the field. Field notes were also taken during the interview process so as to enable us complete statistics obtained through the questionnaires. Published and unpublished research works, textbooks and articles made up sources of secondary data obtained through the IRAD library and other online sources.

Methods for the study on the identification of the different potato varieties, their conservation, commercialization and consumption

The activity on case specific varietal characteristics, conservation and transformation process of Irish potato in the Adamawa region of Cameroun was carried out in Ngaoundere 1, 2 and 3e Sub-Divisions all belonging to the Vina Division, one of the five divisions found in the Adamawa Region of Cameroon. These sites were selected because potato is produced, sold, transformed and consumed there. To this, a survey was carried out among the various actors within the potato sector in the city of Ngaoundere. The survey methodology was a random and totally inclusive process for all potato producers. A survey form was established. The survey was conducted among producers (32), sellers (48), consumers (29) and transformers (26) in each main market of each Sub-Division. The interviews focused on the following information: profile of respondents; different varieties; description of processed products; method of conservation of the raw materials and the products; constraints linked to conditioning and storage of potatoes; constraints linked to potato commercialization and constraints linked to potato transformation.

On the physico-chemical characterisation of fresh potatoes identified during the survey and available on the market, the Cardinal, Bafoussam, Doza, Panamera and Cipira cultivars were characterized. The following Physico-chemical characteristics were determined: number of eyes (buds) per count; size (length and diameter) measured with the help of a caliper of type Roche (France); geometric median diameter (Dg), the sphericity (Ø) and the surface area of the tubers were calculated according to the following equations proposed by Demir & Kalyoncu (2003) and Topuz *et al*. (2005): $Dg = (LD^2)^{1/3}$; $Ø = Dg/L$; $S = \mu D^2 g$. The form was determined by visual description while the average mass of a tuber was gotten with a balance. The waste yield is equal to the ratio of the waste (peelings) mass/total mass of the potato. The waste mass is obtained after peeling. The pulp yield is equal to the ratio of the pulp mass/total mass of the potato. The pulp mass is obtained after peeling. The dry matter content was obtained by the AOAC (1990) methods. The soluble dry extract (Brix degree or sugar content) by refractometric evaluation with the help of a pocket PAL-1 ATAGO refractometer. The pH with a pH-meter.

The osmotic dehydration (O.D) method which is a method of reducing the water contained obtained by immersing the potatoes, whole or in pieces, in a salt solution (NaCl) or a solution of various sugars (Maltini and Torreggiani, 2003) was used. For the production of poached

potatoes, a salt solution was used for this study. After soaking, the potatoes were pre-fried in previously heated oil. Plant material and ingredients used for analysis were those available on the market: Doza, Cipira and Bafoussam. The ingredients used were table salt (NaCl), water and cooking oil. For dehydration, the potatoes were washed, peeled with a peeler, rinsed with tap water and then sliced in a round-shaped form and in lamellae with a mandolin. Figure 5 shows the procedure used in obtaining poached potatoes. The dehydrated parameters (O.D) of the potatoes include the following: Solute: NaCl (5, 10%); time (minutes): 30, 60, 120 minutes; ratio: 1/10 (m/v). The osmotic solution was prepared by dissolving NaCl in tap water. Two replications were done per sample. 200 g potato lamellae were soaked in 2000 ml of the salt solution at 5% and 10% rates previously cooked for 30 minutes, 1 hour and 2 hours: each case was repeated once, and the soaking durations were timed by a mechanical laboratory stop watch. At the end of each soaking period, for each case, the samples were dried, reweighed and pre-fried. At the same time, the individual potato slices were weighed, soaked, dried and put in the oven at 105°C for 24 hours to determine the water content and also the dry matter content. At the end of the latter, the dry matter (DM) of each dehydrated sample was determined.

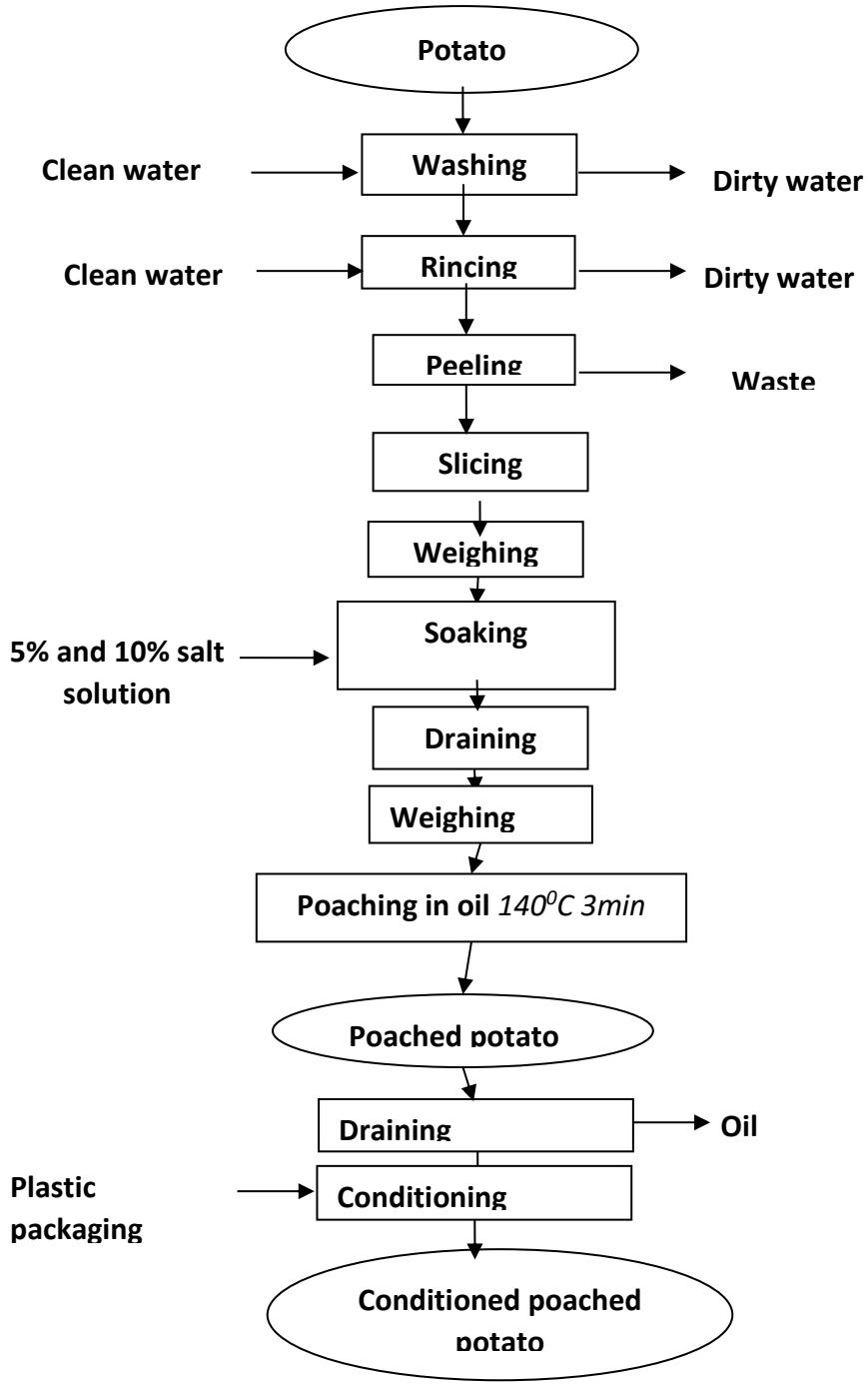


Figure 5: Steps involved in the production of poached potatoes

Another activity of the study was to have a descriptive characterisation of potato chips and to determine the variety that can be used for chips production. Considering the availability of potatoes, the varieties used for chips production were Cipira and Doza. The ingredients used were cotton oil and table salt. Round potatoes with thickness of 1 mm were obtained with the help of a mandolin. The trials were prepared in the laboratory. The chips were produced following the procedure on Figure 6.

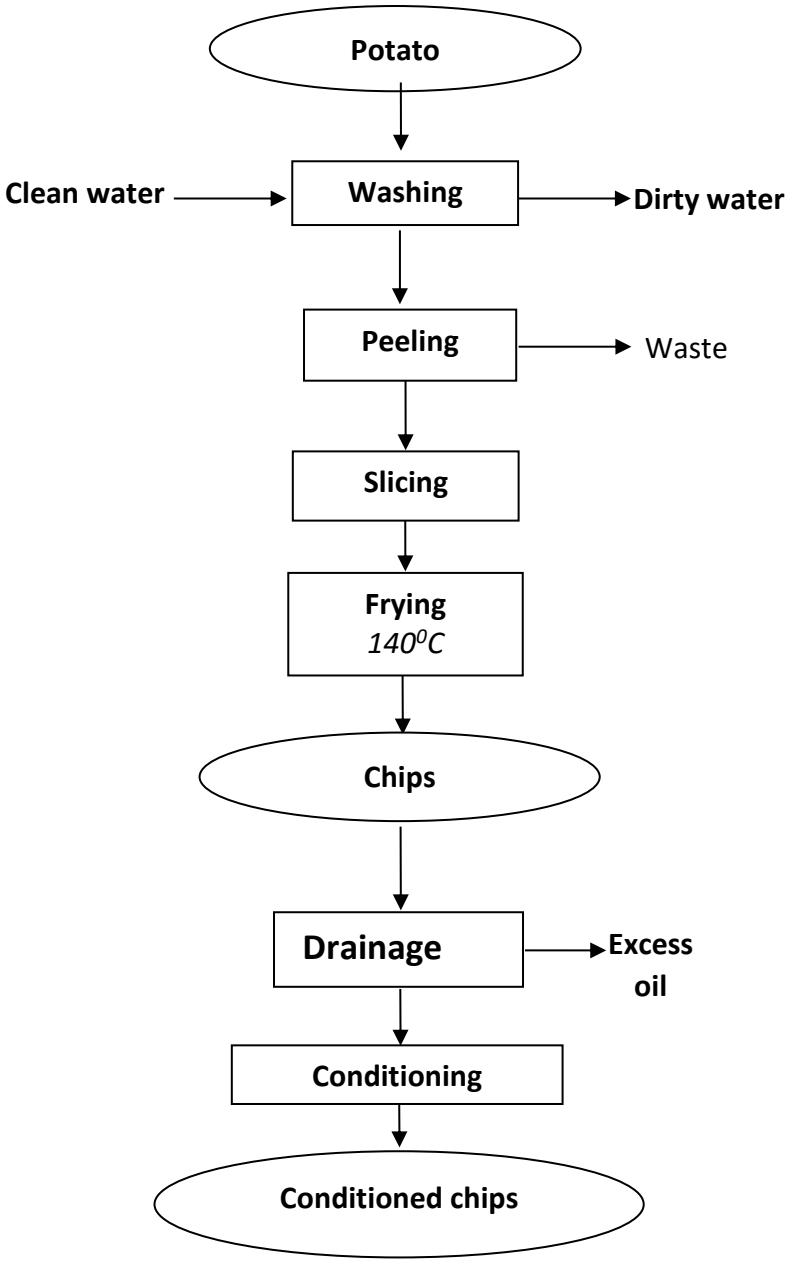


Figure 6: Procedure for potato chips production

Sensory analysis was done to determine the degree of acceptability of potato chips by consumers in Ngaoundere. Sensory analysis is defined by ISO as the examination of the organoleptic properties of a product by the sensory organs (sight, hearing, touch, smell and taste). Potato chips obtained were subjected to sensory analysis according to the analytical approach according to the descriptive test that enables the evaluation of product properties, and the parameters analysed include: Colour (more or less golden), variable from 0 to 10; the impression of fat in the chips (more or less serious) with oily character, intensity from 0 to 10; Chips taste/ (variable more or less) of bad taste.

Methods on the analysis of supply and distribution systems of food prepared out of the home in big cities: the case of potato in Yaounde

This survey was realized in 3 stages: an exploratory survey was carried out in the 07 subdivisions of the Mfoundi division, the aim of which was to identify the market locations and types of ready-to-eat potato-based dishes, to meet the enterprise managers (restaurant owners), those responsible for road-side restaurants and others. Then a second survey was conducted after the interviewers had been trained in the office, the descent with an interview guide that aimed to test the interviewers' ability to understand the proposed questions first, adjust questions that seemed to have a lot of impact on the respondents, test accessibility with clients who did not always seem to agree that they were on a break, were in transit and did not have enough time to give the interviewers; find better strategies for the next descent. The third descent therefore consisted of the survey proper with questionnaires suitably adjusted to obtain reliable information and above all to reach several strata. From the onset, a survey of potato products was performed in two subdivisions of Yaounde (I and II) where potato consumption is most represented. Yaounde, the capital of the Mfoundi department, is a predominantly urban area inhabited by a cosmopolitan population composed of all the country's major ethnic groups (Sudano-Sahelians, Fang-Béti, Grassfields and Sawas) as well as foreigners (Akoa-Etoa et al., 2017). To gather the necessary information for our study, we first collected secondary data (i.e. pre-existing data through literature review, internet research, and scientific publications) and then primary data (i.e. original data collected by us for our specific study). The primary quantitative data mainly concerned the description of the types of restaurants, the potato by-products cooked and marketed, the overhead costs involved in purchasing the dish offered by the restaurants to consumers. To this end, the use of the quota sampling method or reasoned choice sampling was the most appropriate because of the absence of an official directory of potato consumers in restaurants in the capital city of Cameroon. We chose to survey mainly in the most concentrated areas, the areas where potato consumption was more representative (hubs, large markets, commercial areas). Akoa et al, (2017) showed that markets and these major hubs are the places where it is easy to find ready-to-eat meal outlets. This assertion was proven by the first exploratory survey which was previously carried out by seven highly qualified investigators in the seven subdivisions of Mfoundi and as the exploratory survey was carried out, some subdivisions were eliminated due to the non-commercialization of potato by-products in a consistent manner. Purposive sampling is the method based on the assumption that the different characteristics of the population are correlated, which explains the sample chosen in such a way as to present a statistical distribution of certain characteristics, select by design identical to that of the population from which it was taken, with a high probability of being very close to that population with regard to the other characteristics. For the survey itself, a selection of subdivisions and restaurants in which it was very likely to meet potato consumers was selected, hence the questionnaire which contained open-ended questions to allow respondents to express themselves better, to reveal hidden information that could not be discovered through the variables previously proposed by the interviewers, then the semi-open questions. For this study, 125 respondents in Yaounde 1 and 90 in Yaounde 2 were interviewed.

Statistical analysis

The software used for quantitative data processing and descriptive statistics was SPSS 16.0. SphinxME11 and EXCEL 2013 were used for qualitative data processing and content analysis (Bourbonnais, 2015; Croizean et al., 2009; Vidal, 2009). The descriptive analysis were based on frequencies, means, standard deviations, minimum and maximum numbers. This included the use of frequency tables, percentages and means of distributions. Word verbatim reporting was done on information obtained from some households on striking issues like the procurement of Irish potato and styles of utilisation. Citations were used to report on types of Irish potato meals prepared and preferred by households in producing and non-producing areas. Results were presented on tables and graphs. The data obtained for technological quality of potato tubers were analysed and expressed as Mean ± SD and those from the sensory evaluation by panelists, were subjected to the Analysis of Variance (ANOVA) using the Statgraphics Plus, version 5.0 statistical package. The means obtained were separated using the Fischer Test ($P \leq 0.05$).

For the varietal characteristics, conservation and transformation processes of Irish potato in the Adamawa region of Cameroun, experimental data obtained were treated using Excel and the data analysed using the SPSS statistical package to draw the curves showing variations in water content. The panel constituted 29 subjects composed of 82.75% men and of 17.25% women. The majority had ages greater than or equal to 30 years (82.76%). They were recruited within IRAD Wakwa. The subjects evaluated the chips in a hall at room temperature. The test was done in one session. The jury noted the 2 chips products with respect to a scale ranging from 1 to 10. Descriptive statistics, analysis of variance, plotting of graphs and curves were done using Microsoft Excel and SPSS version 15. The results of the sensory analyses were treated with the Excel spreadsheet. In effect, the average scores were determined.

Results and Discussion

Assessment of the suitability of potato to various processing techniques

Internal and external parameters

The first specific objective was to investigate the suitability of potato varieties to processing techniques, in order to identify their best forms of consumption and potential industrial use. Apart from Cipira, Jacob2005 and Mondial with shallow eyes, all the other varieties had deep eyes. Cipira, Mumbi, Banso and Belo varieties registered a high dry matter content (>20 %) with that of Cipira being the highest (26.45%). An appraisal of the technological quality of the tubers indicated that Cipira, Mumbi, Banso and Belo varieties had best characteristics for frying, mashing and roasting, with Cipira and Mumbi ideal for fries with respect to size and Banso and Belo ideal for crisps. On the other hand, Dosa and Jacob were better suited for mashing and roasting while tubers of Mondial where shown to be suitable for boiling and more appropriate to be consumed in the form of salads. The best overall acceptability of potato fries and boiled potato was recorded for products made with Cipira, Banso and Mumbi varieties. Each of these varieties is therefore of importance as its cultivation can target a particular processing technique. On external parameters of potato varieties as presented on Table 5, Mondial tubers (91.45mm) were the longest while those of Jacob 2005 and Dosa were similar in length (46.74mm and 47.05mm respectively) and the shortest. The tubers of

Cipira, Mumbi and Dosa recorded the largest mean diameters >55mm. The desired tuber sizes depend on the product envisaged. For industries processing potatoes, tubers larger than 50 mm are ideal for French fries while tubers between 40 to 60 mm are ideal for crisps (Haase et al., 2007; Kabira and Lemanga, 2003). Therefore, considering the size of tubers alone, Cipira, Mumbi and Dosa will be ideal for fries while all of the varieties will be good for crisps.

Table 5: Potato Tuber size, shape and presence of eyes (buds) with respect to variety

Variety	Tuber size		Tuber Shape		Presence of eyes	
	Length (mm)	Diameter (mm)	Index Value	Shape	No. of Eyes	Eye-depth
CIPIRA	62.86±4.43	58.65±4.16	107.18	Round	9	Shallow
JACOB 2005	46.74	45.95	101.72	Round	8	Shallow
MUMBI	61.90±4,24	57.53±0.90	107.59	Round	11	Deep
BANSO	52.97±8.12	43.33±5.62	122.23	Short-Oval	9	Deep
BELO	57.88±2,02	42.28±7.25	136.90	Oval	10	Deep
MONDIAL	91.45	45.90	199.24	Long	9	Shallow
DOSA	47.05	55.40	84.93	Round	10	Deep

The shapes of the tubers as per the index value were in line with the physical observations. According to Linsinska et al. (2009), round or oval potato tubers are selected for crisps and dehydrated products while oblong or oval varieties will be suitable for fries. Unlike potato tuber size that is influenced by cultural practices, shape and eye-depth are varietal characteristics. Varieties with shallow eyes are mostly preferred for processing as deep eyes result in higher peeling loses (Kabira and Lemanga, 2003). Apart from Cipira, Jacob 2005 and Mondial with shallow eyes, all the other varieties have deep eyes.

Internal parameters are analysed as on shown on Table 6. The varieties analysed showed dry matter values ranging from 15.43 to 26.45 % and percentage moisture ranging from 73.55 to 84.57%. The texture and oiliness of processed potato products is partly determined by dry matter content. A level of potato tuber dry matter content above 20% is best for fries and crisps because it results in higher product yield and profitability, improves crispness of the fried products and prevents excessive fat absorption during frying (Ekin, 2011; Kabira and Lemanga, 2003). The dry matter content of Mondial tubers (15.43) therefore indicates that this variety is not best for fries. Based on the classification used by Feltran (2004), Cipira, Mumbi, Banso and Belo varieties with high dry matter (>20) are good for frying, mashing and roasting, whereas Dosa and Jacob have intermediate dry matter content (between 18 and 19.9 %); preferred for mashing and roasting (lesser extent frying) and Mondial in the group of low dry matter content (<17.9 %) will be more appropriate for salads.

Table 6: Dry matter content, percentage moisture soluble solids, pH and titratable acidity of potato variety tubers.

Variety	Dry matter (%)	Moisture (%)	soluble solids (°Brix)	Pulp pH	Titratable acidity (% malic acid)
CIPIRA	26.45±1.00	73.55±1.00	5.25±0.5	6.24±0.22	0.23±0.07
JACOB 2005	18.86	81.14	4.50	6.24	0.25
MUMBI	24.89±1.68	75.11±1.68	5.50±0.87	6.30±0.18	0.28±o.04
BANSO	25.27±1.32	74.73±1.32	5.25±0.25	6.45±0.13	0.29±0.04
BELO	25.63±0.05	74.37±0.05	5.50±0.00	6.49±0.06	0.29±0.03
MONDIAL	15.43	84.57	4.50	6.14	0.22
DOSA	19.42	80.58	5.00	6.36	0.25

The soluble solids (sugar content) obtained for varieties studied ranged from 4.5 to 5.5°Brix. Mumbi and Belo had the highest values indicating the presence of more sucrose. The soluble solids recorded for Mondial (4.5°Brix) was the same as that obtained by Fernandes et al. (2015) and similar to the 4.88°Brix obtained for the same variety by Feltran et al. (2004). High sugar content increase tuber susceptibility to browning during processing and results in undesired sweet flavour of cooked potatoes (Lisinska et al., 2009). The pulp pH obtained for the varieties ranged from 6.14 to 6.49 with the Belo variety recording the highest pH closely followed by Banso. The pH values recorded in this study were higher than the 5.16 to 5.94 recorded by Feltran et al. (2004). This indicates that these tubers have a greater probability of undergoing a faster fermentation. The values of titratable acidity here obtained (0.22 to 0.29 %) are higher than 0.15 to 0.19 % obtained by Fernandes et al. (2015) for Agata and Mondial varieties grown with different levels of phosphorus fertilization. It resulted from that study that, greater availability of phosphorus can reduce the amount of organic acids in the tubers; the high acidity recorded in this study could therefore be as a result of low phosphorus fertilisation.

As concerns Flesh colour, and as on Table 7, apart from Jacob 2005 with a white colour, all the other varieties were cream in colour. Upon exposure of cut tubers to air for a period of time, a discoloration of the tubers was observed with the colour turning to brown. This browning reaction is caused by the oxidation of phenolic compounds by the enzyme phenolase (Kabira and Lemanga, 2003). Cut tubers of Belo and Dosa varieties kept longer (> 90 minutes) without any noticeable change in colour wheras in < 30 mins, Jacob 2005 became discoloured. It was also observed that for some tubers the browning did not occur on the whole surface of the slice but in a ring a few mm inside the skin of the potato. According to Buch (1999), this usually reflects mechanical damage (knocks and bruises) from rough handling during and/or after harvest. Potato tubers that are susceptible to browning affects the colour of its processed products.

Table 7: Tuber flesh colour and time taken for browning after exposure to air

Variety	Flesh colour	Time of exposure before browning (Minutes)
CIPIRA	Cream	30 - 60
JACOB 2005	Whitish	< 30
MUMBI	Cream	30 - 60
BANSO	Cream	30 - 60
BELO	Cream	> 90
MONDIAL	Cream	30 - 60
DOSA	Cream	> 90

The potato varieties with highest peel losses (28.33%) were Banso and Belo varieties closely followed by Dosa (27.42%) (Figure 7). These are all varieties with deep eyes, confirming the assertion that deep eyes result in higher peel losses (Kabira and Lemanga, 2003). However, Mumbi also having deep eyes registered a lower loss (16.67) and this could be due to the fact that this variety had a similar number of eyes like Banso, Belo and Dosa but on a larger surface area. The lowest peel loss (16%) was registered for Cipira tubers.

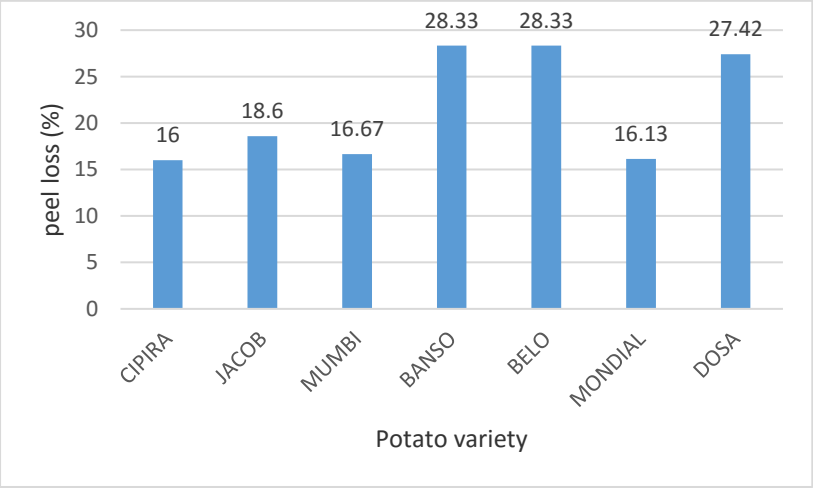


Figure 7: Percentage peel loss per potato variety

Sensory properties

Food is generally appreciated by its flavour and appearance. Flavour is a distinctive quality that comes from a food's unique blend of appearance, taste, odour, feel, and sound. Appearance is based on habit and preconceived notions like garnish- which is a decorative arrangement added to food or drink, texture which may be soft, brittle, grainy, chewy, hard, tender, dry, etc. Another parameter of food is mouthfeel how a food feels in the mouth, taste

and sound which maybe crunchy foods need to sound crunchy, crackers you don't want to be soggy. All these characteristics are examined and taken into consideration in doing a sensory analysis (Alessandrini et al. 2010, Lawless and Heymann, 2010). Sensory analysis of a food product may be a subjective expression of certain sensory parameter that help determine the choice of food and people's willingness to consume specific food cooked foods. Sensory evaluation is therefore a scientifically accepted way of testing food using the human senses of sight, smell, taste, touch and hearing (Alessandrini et al., 2010, Lawless and Heymann, 2010, Van Dijk et al., 2002). Sensory characteristics depend on the qualities of a food identified by the senses. How it looks, tastes, smells, sounds and feels when eaten. The interpretation and conclusion of the results of a sensory analysis requires a consideration of the data, results and analysis. This involves an understanding of how the method was performed, the background of the panelists, limitations in the experiment and framework of the study. Sensory testing methods are of three kinds. Discrimination test tries to answer the question are products perceptibly different in any way while descriptive test tries to answer the question how do products differ in specific sensory characteristics and affective taste (hedonic) will answer the question how well are products liked or which products are preferred (Lawless and Heymann, 2010). Food choices is influenced by culture and geography, emotions and psychology, beliefs, health concerns, food costs, technology and cooking methods. The impression of a food consumed by different people may vary from one group to another. Often consumers trend to choose certain food products because of their taste, health, interest, convenience, inexpensive etc. Such parameters can be further confirmed through a sensory evaluation which is a method to measure, analyse, evoke and interpret the response given by a panellist to a set of characteristics regarding specific food item or a group of food items. It is a mechanism to create a meaningful relationship between human sensory perception and the acceptance or appreciation of certain food types. Since the data collected from the sensory evaluation is usually variable, it is important to properly apply statistical tools during the analysis of the data from the panelists. Fresh potatoes have around 80 % water and 20 % dry matter. From the dry matter content, 60 to 80 percent is starch. Potatoes are one of the tubers that are known as a good source of potassium (897 mg), vitamin B6 (0.62 mg) and fibre as well as vitamin C (42 mg) (FAO, 2008). Irrespective of the technology and form into which potato is processed and cooked in Cameroon, they are peeled before processing starts. After peeling, they are either fried or boiled and the processing continue from there. This means pealing, frying or boiling are the basic steps of potatoes cookery in Cameroon and therefore any evaluation at this stage can give an excellent perception of what consumers' preference would be of the final product.

Potato fries: Amongst all the potato varieties studied, the colour of fried potato was less ($p \leq 0.05$) appreciated for Jacob 2005. Banso showed the best colour from the score attributed which was comparable ($p > 0.05$) with scores for Cipira, Mumbi and Mondial (Table 8). The texture of fried potato samples were highly appreciated for Cipira, Banso, Mumbi which recorded similar ($p > 0.05$) scores while the texture of Dosa, Mondial, Jacob 2005 and Belo were not significantly less appreciated ($p > 0.05$). A similar trend was observed for the flavour attribute. Mumbi, Banso and Cipira presented the highest scores in terms of overall acceptability of fried potato samples. Those scores were similar ($p > 0.05$) and significantly

(p≤0.05) greater than those of other samples. When fried, Mondial showed the lowest overall acceptability score compared with the other varieties and not significantly (p>0.05) different with scores of Jacob 2005 and Belo.

Table 8: Sensory scores of potato fries

Potato variety	Colour	Texture	Flavour	Overall acceptability
CIPIRA	7.71±1.06[a]	8.14±0.66[a]	7.28±0.72[a]	8.14±0.36[a]
JACOB 2005	5.71±1.63[c]	6.42±1.08[b]	6.14±1.29[b]	6.42±1.45[bc]
MUMBI	7.57±1.82[ab]	7.85±0.86[a]	7.71±0.46[a]	8.28±0.91[a]
BANSO	8.00±0.78[a]	8.14±0.86[a]	7.57±0.93[a]	8.14±0.86[a]
BELO	6.85±0.86[b]	6.57±0.93[b]	6.42±1.08[b]	6.71±0.91[bc]
MONDIAL	7.25±0.44[ab]	5.87±1.31[b]	5.87±1.50[b]	6.12±1.31[c]
DOSA	6.87±0.80[b]	6.12±0.80[b]	6.50±1.03[b]	7.00±0.73[b]

(a, b, c): Values with the same superscript letter in the same column are not significant different (P>0.05).

The effect of age on the sensory evaluation of potato fries was analysed and from Table 9, it can be observed that the age of panellists did not affect (p>0.05) the appreciation of sensory attributes of fried Dosa, Mondial, Jacob 2005 and Belo varieties but panel members of more than 30 years less appreciated (p≤0.05) all the sensory attributes for fried Mumbi variety and the colour of fried potato when Banso and Cipira varieties where used. Except for Mondial and Mumbi Varieties, the overall acceptability of potato fries from the other varieties were not affected by the age of the panellists. However, the potato fries were scored as acceptable by both age groups.

Table 9: Sensory evaluation scores of fried potato with respect to age group (years)

	Sensory attributes							
Potato	**Colour**		**Texture**		**Flavour**		**Overall acceptability**	
variety	≤ 30	> 30	≤ 30	> 30	≤ 30	> 30	≤ 30	> 30
Dosa	6.8±1.03	7.0±0.00	6.2±0.78	6.0±0.89	6.2±1.03	7.0±0.89	7.2±0.78	6.66±0.51
Mondial	7.4±0.51	7.0±0.00	5.4±1.42	6.66±0.51	5.4±1.07	6.66±1.86	5.6±1.26	7.0±0.89*
Mumbi	8.75±0.46*	6.0±1.78	8.25±0.46*	7.33±1.03	8.0±0.00*	7.33±0.51	9.0±0.00*	7.33±0.51
Jacob	5.75±1.38	5.66±2.06	6.75±1.16	6.0±0.89	5.75±1.58	6.66±0.51	6.5±1.60	6.33±1.36
Banso	8.5±0.53*	7.33±0.51	8.25±0.88	8.0±0.89	7.5±0.92	7.66±1.03	8.25±0.88	8.0±0.89
Cipira	8.25±0.88*	7.0±0.89	8.25±0.46	8.0±0.89	7.25±0.46	7.33±1.03	8.25±0.46	8.0±0.00
Belo	7.0±1.06	6.66±0.51	6.75±0.46	6.33±1.36	5.75±0.88	7.33±0.51	6.5±0.92	7.0±0.89

(*): The value with this symbol for the same sensory attribute and for each potato variety is significantly different (p≤0.05)

Gender effects on sensory evaluation of potato fries was analysed as on Table 9. The results obtained for potato fries indicate that, except for Mumbi variety which registered a significantly low ($p \leq 0.05$) appreciation of all sensory attributes by the male and the significantly better female appreciation of the texture and the colour of Belo and Banso varieties respectively, gender did not significantly affect ($p > 0.05$) the level of appreciation of sensory attributes for the other varieties.

Table 9: Sensory evaluation scores of fried potato with respect to gender

	Sensory attributes							
Potato variety	**Colour**		**Texture**		**Flavour**		**Overall acceptability**	
	Male	**Female**	**Male**	**Female**	**Male**	**Female**	**Male**	**Female**
Dosa	7.0±0.00	6.8±1.03	6.0±0.89	6.2±0.78	7.0±0.89	6.2±1.03	6.66±0.51	7.2±0.78
Mondial	7.0±0.00	7.4±0.51	6.0±1.54	5.8±1.22	6.0±2.36	5.8±0.78	6.0±1.78	6.2±1.03
Mumbi	5.0±1.15	8.6±0.51*	7.0±1.15	8.2±0.42*	7.0±0.00	8.0±0.00*	7.0±0.00	8.8±0.42*
Jacob	5.0±2.30	6.0±1.33	6.6±1.15	6.6±1.07	7.0±0.00	5.8±1.39	6.5±1.73	6.4±1.42
Banso	7.5±0.57	8.2±0.78*	8.5±0.57	8.0±0.94	8.0±1.15	7.4±0.84	8.5±0.57	8.0±0.94
Cipira	6.5±0.57	8.2±0.78	8.0±1.15	8.2±0.42	7.0±1.15	7.4±0.51	8.0±0.00	8.2±0.42
Belo	6.5±0.57	7.0±0.94	5.5±0.57	7.0±0.66*	7.0±0.00	6.2±1.22	7.0±1.15	6.6±0.84

(*): For the same sensory attribute and for each potato variety, the value with this symbol is significantly different ($p \leq 0.05$).

Boiled potatoes: From Table 10, the boiled Cipira variety indicated the highest score with regards to colour and this value was significantly ($p \leq 0.05$) different from those of Jacob 2005, Belo and Banso. On the other hand, the boiled tuber colour of Jacob 2005 was less appreciated ($p \leq 0.05$) by panellists followed by Belo Variety. The texture of Boiled Belo tubers were significantly more appreciated ($p \leq 0.05$) by the panel members compared to the boiled tubers of Jacob 2005 and Mondial varieties. However, apart from the Belo Variety, all other boiled varieties had similar appraisal ($p > 0.05$) in terms of texture. Mondial and Jacob 2005 obtained the same lowest score for flavour of boiled potato which was comparable ($p > 0.05$) to those of Belo and Mumbi. However, the flavour of Cipira was highly appreciated but at the same level with the flavour of Dosa, Banso and Belo. Looking at the Overall acceptability of boiled tubers, Cipira registered the highest score which was not significantly ($p > 0.05$) different from those of Banso, Belo and Mumbi. Whereas, the lowest acceptability from panellist was with Jacob 2005 which showed no significant difference ($p > 0.05$) with Mondial and Dosa.

Table 10: Sensory scores of boiled potato

Potato variety	**Colour**	**Texture**	**Flavour**	**Overall acceptability**
CIPIRA	7.50 ± 0.73^{a}	6.87 ± 1.31^{ab}	7.37 ± 1.25^{a}	7.62 ± 0.88^{a}
JACOB 2005	4.50 ± 1.54^{d}	6.12 ± 1.74^{b}	5.62 ± 1.36^{c}	5.87 ± 1.89^{c}
MUMBI	7.37 ± 1.02^{ab}	7.00 ± 1.03^{ab}	6.37 ± 1.25^{bc}	7.00 ± 1.26^{ab}

BANSO	6.50±1.36^{bc}	7.00±1.03^{ab}	6.62±1.25^{ab}	7.12±1.31^{ab}
BELO	6.12±1.58^{c}	7.25±0.44^{a}	6.50±1.54^{abc}	7.00±1.26^{ab}
MONDIAL	7.00±1.71^{abc}	6.12±2.15^{b}	5.62±1.92^{c}	6.25±1.84^{bc}
DOSA	6.62±1.45^{abc}	6.62±0.88^{ab}	6.62±0.88^{ab}	6.62±0.88^{bc}

(a,b,c): Values with the same superscript letter in the same column are not significant different (P>0.05)

Looking at age effects on boiled potatoes, apart from the flavour of boiled Cipira variety that was more appreciated by panellist above 30 years, age had no effect (p>0.05) on the sensory attributes of all the other boiled potato samples and the also had no effect on the acceptability (Table 11).

Table 11: Sensory evaluation scores of boiled potato with respect to age group

	Sensory attributes							
Potato	**Colour**		**Texture**		**Flavour**		**Overall acceptabily**	
variety	Age ≤ 30	> 30	≤ 30	> 30	≤ 30	> 30	≤ 30	> 30
Dosa	7.0±2.00	6.25±0.46	7.0±0.75	6.25±0.88	7.0±0.75	6.25±0.88	7.0±0.75	6.25±0.88
Mondial	7.0±1.85	7.0±1.69	6.0±2.50	6.25±1.90	5.5±2.44	5.75±1.38	6.25±2.05	6.25±1.75
Mumbi	7.25±1.16	7.5±0.92	7.0±0.75	7.0±1.30	6.5±0.92	6.25±1.58	7.5±1.19	6.5±1.19
Jacob	4.0±1.69	5.0±1.30	6.25±1.58	6.0±2.00	5.5±1.19	5.75±1.58	5.75±1.90	6.0±2.00
Banso	6.5±1.19	6.5±1.60	7.0±1.30	7.0±0.75	7.0±1.30	6.25±0.75	7.25±0.88	7.0±1.69
Cipira	7.75±0.46	7.25±0.88	6.25±1.58	7.5±0.53	6.75±1.58	8.0±0.00*	7.25±0.88	8.0±0.75
Belo	6.25±1.38	6.0±1.85	7.25±0.46	7.25±0.46	6.5±0.53	6.5±2.20	7.25±0.46	6.75±1.75

(*): the value with this symbol for the same sensory attribute and for each potato variety is significantly different (p≤0.05)

The sensory scores for boiled potatoes showed no significant difference in the overall acceptability with respect to gender (Table 12) except for Dosa that registered a better acceptability score by the female. The female also better appreciated the flavour of the boiled Dosa variety and the colour of the boiled Cipira; apart from these, the sensory attributes were not affected by the gender for the other varieties.

Table 12: Sensory evaluation scores of boiled potato with respect to gender

	Sensory attributes							
Potato	**Colour**		**Texture**		**Flavour**		**Overall acceptability**	
variety	**Male**	**Female**	**Male**	**Female**	**Male**	**Female**	**Male**	**Female**
Dosa	6.0±0.00	7.0±1.76	6.33±1.03	6.8±0.78	6.0±0.89	7.0±0.66*	6.0±0.89	7.0±0.66*
Mondial	7.33±1.86	6.8±1.68	6.33±2.25	6.0±2.21	6.0±1.54	5.4±2.17	6.33±2.06	6.2±1.81
Mumbi	7.33±1.03	7.4±1.07	7.0±1.54	7.0±0.66	6.0±1.78	6.6±0.84	6.33±1.36	7.4±1.07
Jacob	4.66±1.36	4.4±1.71	6.33±2.25	6.0±1.49	6.0±1.78	5.4±1.07	6.33±2.25	5.6±1.71
Banso	6.66±1.86	6.4±1.07	7.33±0.51	6.8±1.22	6.33±1.36	6.8±1.22	7.33±1.86	7.0±0.94
Cipira	7.0±0.89	7.8±0.42*	7.33±0.51	6.6±1.57	8.0±0.00	7.0±1.49	8.0±0.89	7.4±0.84
Belo	5.66±2.06	6.4±1.26	7.33±0.51	7.2±0.42	6.33±2.58	6.6±0.51	6.66±2.06	7.2±0.42

(*): For the same sensory attribute and for each potato variety, the value with this symbol is significantly higher (p≤0.05)

Results on the market prospection and consumer's awareness study

The second specific objective was to do a market prospection study on the possibility of introducing potato varieties based on processing forms and processed products into different market niches. Results show that in Cameroon, Irish potato is mainly cultivated in order of importance in rural areas of the West, North-West and North Regions. After cultivation, it is stored and then distributed in urban areas with dense populations. This population is characterized by households which most of the time essentially feed out of home depending on the sector of activity and because of fatigue, lack of time or due to late return home after work. It was also found that potato is most consumed in the fried form in roadside and African restaurants for an average price of 1200 FCFA. The sector is actually promising in a context of high economic challenges for the country and Yaounde in particular.

Potato is a widely used and widely appreciated food in the world. In Cameroon, potatoes are mainly grown, in order of importance, in the rural areas of the Western, Northwestern and Northern regions. Following cultivation, it is conserved and transported to densely populated urban areas in Cameroon. This population is characterized by a labour force which according to the nature of the business sector and circumstance, feeds mainly outside the household due to fatigue, lack of time or returning from work at late hours. Given the diversity of potato-based foods and price diversity, this activity had as objective to analyse the mix-marketing consumption of non-household prepared potatoes in urban areas notably in the subdivisions of Yaoundé 1 and 2. The questionnaire survey shows that the potato is more consumed in the form of French fries and African style restaurants for an average price of FCFA 1200. It appears that this is a promising niche with economic stakes for Cameroon, especially for Yaounde the capital. Results on the identification and description of commercial sites in the city of Yaounde suggested that several hidden or open restaurants existed, including African type restaurants; hotels; supermarkets; informal or roadside (tourney-dos) areas were identified in various subdivisions of the city of Yaounde (Table 13).

Table 13: Number of potato transformers per subdivision

Subdivision	Hotel	Ambulant	Bakery/Supermarket	Restaurant	*Tourne-dos*	Snack bar	Total
Yaounde 1	24	3	23	54	11	50	165
Yaounde 2	18	2	1	50	25	4	100
Yaounde 3	1	1	3	13	22	2	42
Yaounde 4	7	14	3	22	70	5	121
Yaounde 5	14	8	3	23	8	6	62
Yaounde 6	13	10	4	15	1	4	47
Yaounde 7	2	4	2	10	22	3	43
Total	79	42	39	187	159	74	580

Considering the socio-economic analysis of potato-based product traders' profile, street vendors constituted more than 75% of transformers. Irish potatoes food vendors where

repartition by gender. The gender distribution of irish potato food vendors was almost equal as we recorded 56.90% and 47.10% being women and men respectively (Figure 8).

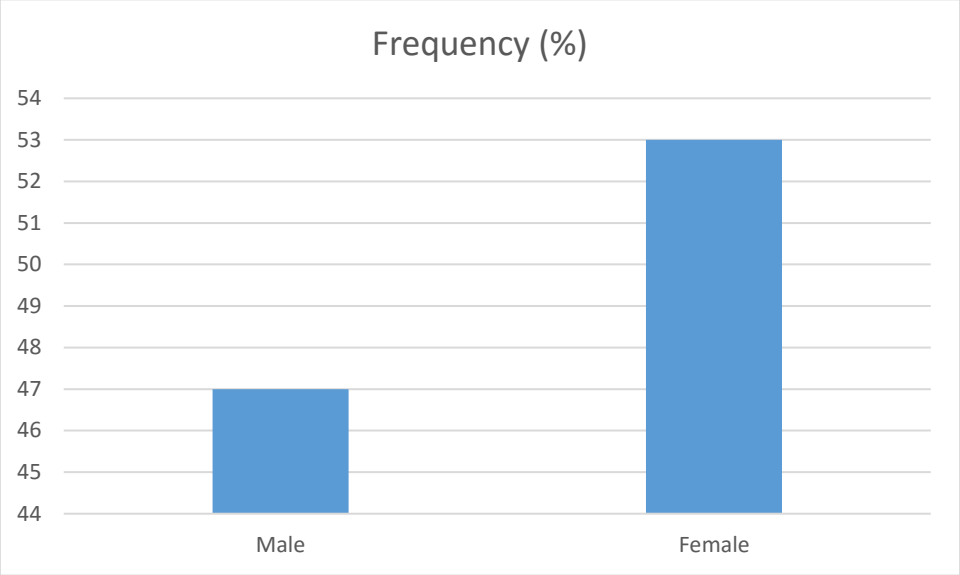


Figure 8: Percentage distribution of irish potato food vendor by gender

The age of the vendors was also analyzed and results are presented on Figure 9. Three main age groups were examined as under 35 which is the youth strata, 35-45 years as the struggling age and above 46 years as the old age since life expectancy in Cameroon is around 48 years.

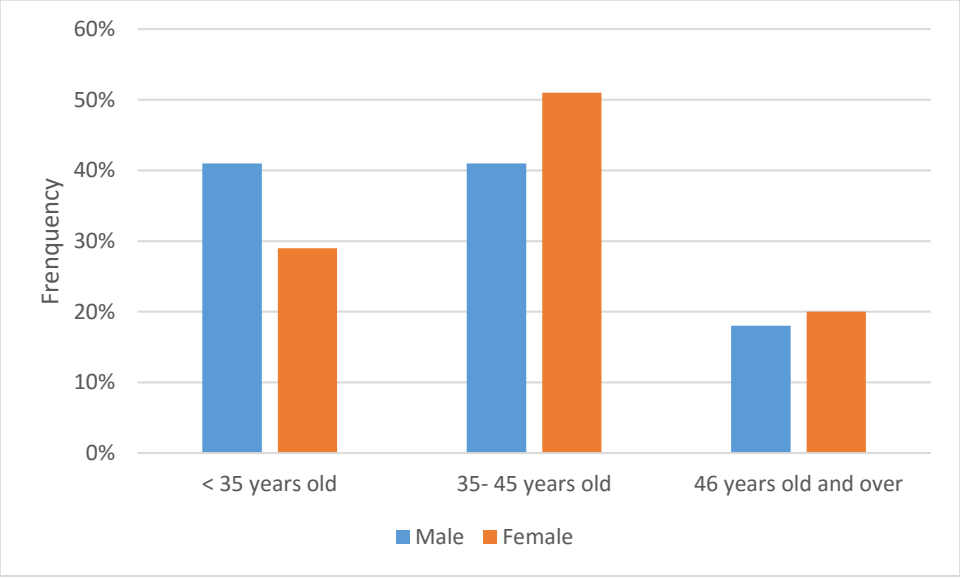


Figure 9: Percentage distribution of restaurateurs by age

There were more men in the under 35s with 41% for men compared to 29% for women. For the older ages, there were more women than men with 51% in the range 35-45 years and 20% in the over 45 age group. Many types of restaurants were inventoried as African type restaurant - this is where food is prepared and served in a normal African way. European type restaurant which is the case that the food is prepared and served in a European fashion,

restaurants located within hotels. These are special because they don't operate like full time restaurants and have restricted number of customers (Figure 10).

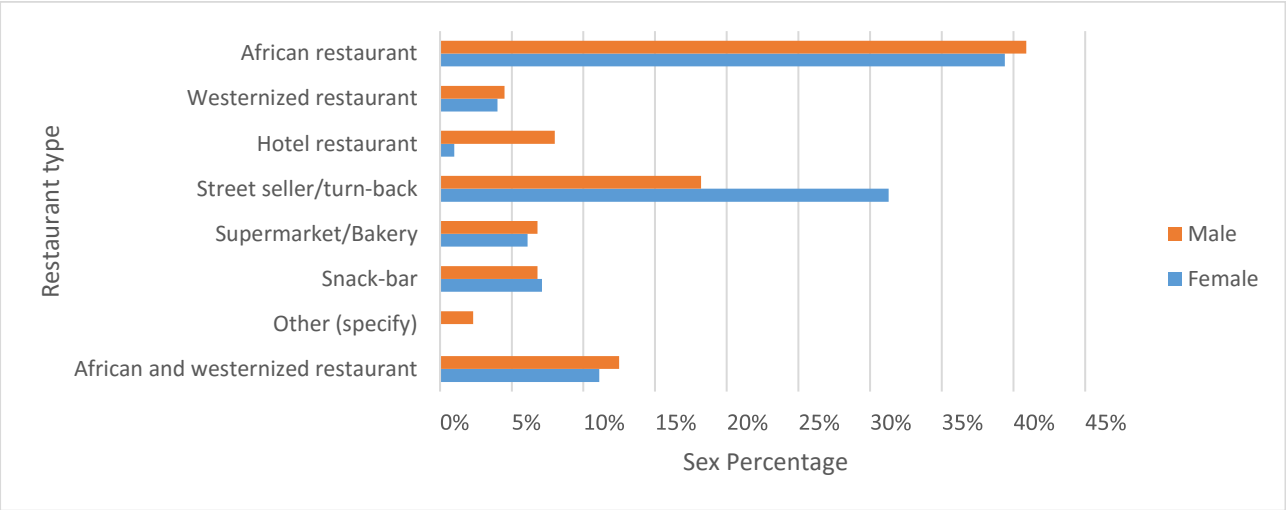


Figure 10: Distribution of ownership of restaurants category by Gender

Looking at figure 10, women dominated as streets vendors compared to the other types in which women and men were in equal proportion while men dominated in hotels. Concerning the types of restaurants, hotel catering is dominated by men with 3.35%. There are more than 19% of men and 21% of women for African type restaurants. Women are slightly more represented in other sectors compared to men. For example, more than 17% of women who are street vendors/ *tourne-dos* compared to men who are close to 9%. On the level of education, it was observed that potatoes food vendors had various levels of education up to university level (Figure 11).

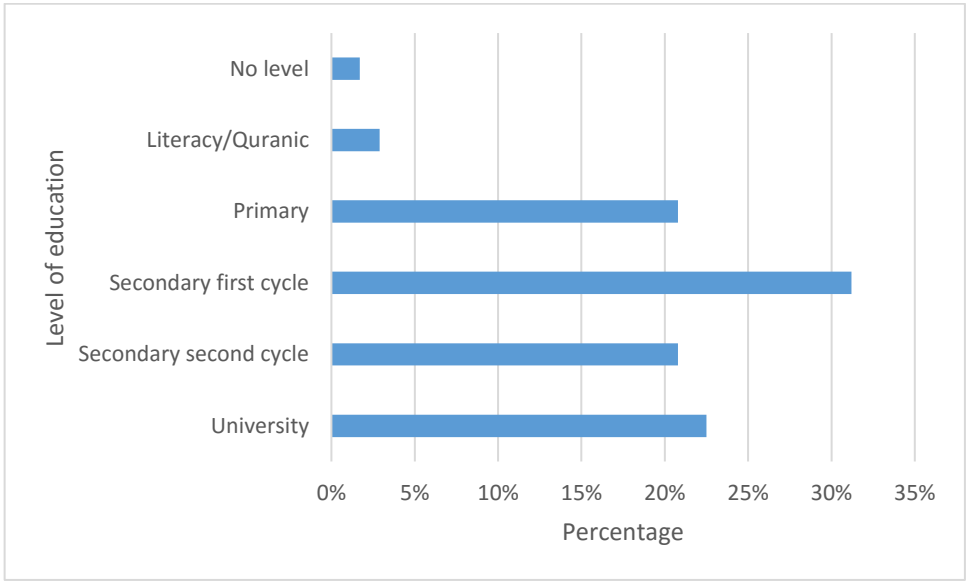


Figure 11: Level of education for restaurant owners

Over 31% of restaurant owners have completed the second cycle of secondary school, i.e. from form 5 to Upper sixth. Then come the academics with over 22%; all those who have spent at least one year at university. We see that this is an industry where actors get started after having sufficiently matured their project. Moreover, it was observed that the more stable forms of restaurant were operated by people with higher educational level. Street vendors where mostly people with no education or with vocational training. Over 13% of African-only restaurant owners have completed upper secondary school. And more than 8% of street vendors / back-turners did the primary. For this sector, the barriers to entry are not as restrictive as in other sectors with charges such as rent, equipment, taxes and duties.

Analysis of mix marketing (4P) aspects of potato-based products

The main components of the mix-marketing approach used in this study are product, price, place and promotion (4P). In restaurants, potato food products are processed into various forms to be consumed either as a compliment with a soup, a salad or a porridge. The units of measurement are not stable as the vendors mostly use traditional measuring unit as bowl, spoon or simply estimate from experience. Being cooked food, it is not often too manipulated and therefore the product is characterized by its processing form. The most consumed form is hotpot potato as a first choice with over 60% followed by pounded potato with 15%. As a second choice, it is the fried potatoes that lead with more than 14% followed by boiled potatoes with more than 13%. Mostly, the shelf life of all potato food products does not exceed 24 hours. In fact, with the customer base increasingly aware of what it consumes, restaurant owners no more keep unsold food in the fridge for the following days' sale. When potato food is lacking in a restaurant, it is substituted by fried or steam plantains although some consumers will abandon the food. The study also reveals that transformers do not bother about the variety and origin of the potato.

The price depends on the level of the restaurant, the type of product and the pre-defined measuring units. For instance, the average price of a plate of fried potato dish is 1,200 FCFA; a dish of pounded potato is 500 FCFA and the price of a plate of potato hotpot is 1000 FCFA. Restaurants receive an average of 25 customers a day. Figure 12 presents the monthly turnover for potato vendors – all categories put together.

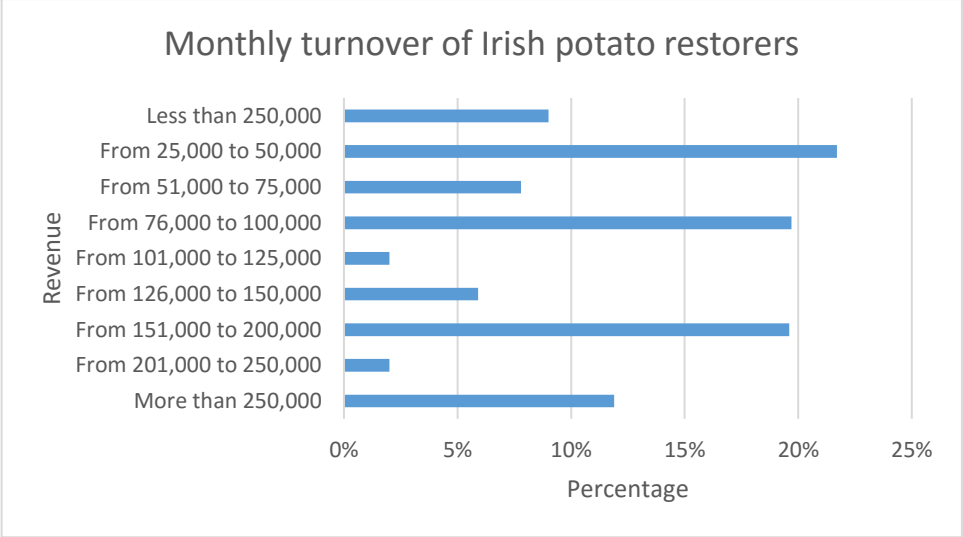


Figure 12: Monthly turnover in FCFA as a percentage of potato vendors

The selling place or space was quite variable even within the same category of vendors. Generally, vendors especially street vendors and those of African restaurants usually located their selling place in busy spots of the streets or around markets. Moreover, beside the physical location, the restaurant types also influenced the location as the vendor placed their restaurants depending on the types of clients they targeted, opportunity of having a place, proximity to their place of residence and potential knowledge about the possibility of having customers. Others also located their restaurants based on other social relationships and organizations like having their tribes' people around who will be the first consumers of their food they will be offering. In all this gender greatly influence the type of restaurant and thus the place as presented in Figure 14. African-style restaurants are the most represented with equal gender distribution; almost 40% woman and man. Western-style restaurants are poorly represented with an average of 4%. This is justified by the fact that Western-style restaurants primarily cater expatriates and other exotic foods. The analysis of the promotion policy is done through experience, staff and others. Vendors experience as potato food sellers is presented in Figure 13.

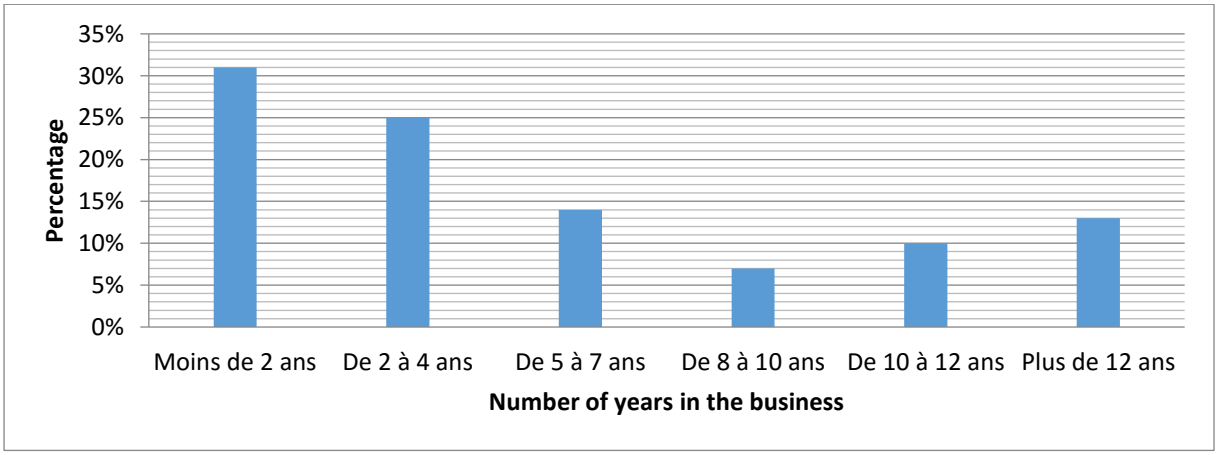


Figure 13: Vendors work experience as potato food vendors

In terms of seniority, 31% of transformers have less than 2 years of experience in the sector and 25% are between 2 and 4 years. This is an attractive business sector. However, several operators start there hoping for a better job. But beyond 4 years, they gain stability, a reference and therefore a brand image is gradually established. The used various advertisement mechanisms as presented in Figure 14.

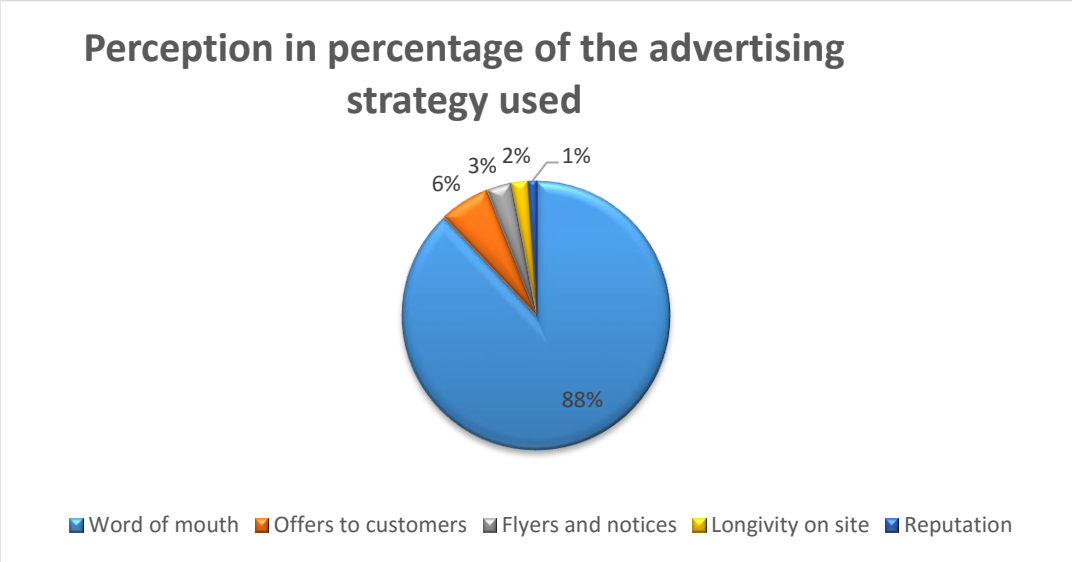


Figure 14: Perception of the type of advertisement used

Advertising is mainly dominated by speaking to nearly 90%. In fact, based on this, a customer will recommend a restaurant to one or more of his acquaintances. Next comes targeted customer offerings (6%) including free tasting campaigns, varied and adapted menus.

Results on consumers' awareness, perceptions and attitudes towards Irish potato procurement and consumption

Socio-economic characteristics of households were analysed for the study on the consumers' awareness, perceptions and attitudes towards Irish potato procurement and consumption in Yaounde, a cosmopolitan city with people from all parts of Cameroon Households were selected from all the ten regions of Cameroon following the various socio-cultural settings. In some regions like the Northwest and the West regions, two groups were considered each. Each category of household captured specific socio-cultural backgrounds that when summed together, a full representation of Cameroon could be observed in the working sample. Specific socio-economic characteristics of households are presented on Table 14. Table 15 shows that the average age of respondents was 37 years for households from producing areas and 35 years for households from on producing areas. Those from producing areas had an average of 5 persons in their households while those from non-producing areas had larger household sizes with an average of six persons per household. In both cases, the households had been resident in Yaounde for at least 13 years with average resident period being 13.4 years for households from producing zones and 13.5 years for households from non-producing zones. This indicates that the households have similar backgrounds of living in the city and provides a higher chance of recording information that was homogenous for households from producing and non-producing areas. Regarding the gender of respondents, they were 78.9%

and 70.0% of female for origins from producing and non-producing areas respectively while males were 21.1% and 30.0% respectively. The marital status was dominated by single 23.3% and 27.8% and married 58.9% and 67.8% for producing and non-producing households respectively. Table 15 shows that the average age of respondents was 37 years for households from producing areas and 35 years for households from on producing areas. Those from producing areas had an average of 5 persons in their households while those from non-producing areas had larger household sizes with an average of six persons per household. In both cases, the households had been resident in Yaounde for at least 13 years with average resident period being 13.4 years for households from producing zones and 13.5 years for households from non-producing zones. This indicates that the households have similar backgrounds of living in the city and provides a higher chance of recording information that was homogenous for households from producing and non-producing areas. Regarding the gender of respondents, they were 78.9% and 70.0% of female for origins from producing and non-producing areas respectively while males were 21.1% and 30.0% respectively. The marital status was dominated by single 23.3% and 27.8% and married 58.9% and 67.8% for producing and non-producing households respectively.

Table 14: Socio-economic variables on households

Variables		**Origins from producing areas**	**Origins from non-producing areas**
Quantitative data (means ± standard deviation)	Age	37.2±13.4	35.7± 10.2
	Household size	5± 3	6± 4
	Number of years resident in the urban centre	13.4± 11.6	13.5± 9.2
	Annual revenue (FCFA)	157777.8± 93663.5	187944.4± 108537.9
Sex (%)	Female	78.9	70.0
	Male	21.1	30.0
Marital status (%)	Living together	1.1	1.1
	Single	23.3	27.8
	Married	58.9	67.8
	Separated/divorced	6.7	1.1
	Widow/Widower	10.0	2.2
Educational level (%)	Muslim education	0.0	5.6
	No formal education	11.1	1.1
	Training school	0.0	2.2
	Primary Education	7.8	11.1
	Secondary Education	18.9	17.8
	High school	24.4	16.7
	University Education	37.8	45.6

Respondents had a reasonable educational level. Although all respondents were found to have all levels of education, the majority had attained university level (37.8% and 45.6%) and at least secondary education (43.3% and 34.5%) for origins from producing and non-producing areas respectively. This shows that people with a higher educational level had a higher chance or urge of travelling probably due to job search or due to occupational calls through transfers.

Irish potato procurement mechanisms: We studied the Irish potato acquisition mechanisms for people from producing and non-producing areas. First, we investigated those who had Irish potato farmers. Here, it was observed that most people from producing areas (92.2%) and non-producing areas (97.8%) did not have a farm. On the contrary, of all those who had a farm, 2.2% and 7.8% came from non-producing and producing areas respectively. This indicates that even in urban areas some households from producing areas have continued to maintain their culture of Irish potato cultivation and rely on these farms as their main source of Irish potato acquisition. On their part, it was interesting to notice that some households from non-producing areas were already getting engaged in Irish potato cultivation meaning that they were highly acculturated and have now found ways of cultivating Irish potato. Most of these farms were found in the villages of origin of these households and these were for households from the west region. This could be associated to their proximity to Yaounde where the study was carried out. This shows that some households have continued to cultivate potato even when they are in the city. A testimony from a 43-year old Bamoun (producing area) man in the Mfoundi neighbourhood goes thus:
My children go to the village every vacation to do farming, interact with other family members and learn our culture. Most food stuff especially Irish potato are very expensive here in the city so I do everything never to buy potato. Our land is very fertile and we grow many crops at no cost. Moreover, my potatoes are bio since I do not use toxic chemicals during their cultivation. When I harvest, I sometimes have up to fifteen 15L-buckets and even more. After I reserve the stock for my family consumption, I share or sell the rest. My wife also likes this idea and when she is chanced, she accompanies the children to the village.

The second means of acquisition was through gift in which 91.1% of households from non-producing areas did not receive potato as gift with only 8.9% acknowledging to receive potato as gifts. On their part, up to 31% of households from producing areas received potato as gifts in Yaounde while 68.9% did not receive potato as gifts. This can also be interpreted by the fact that people from producing areas still have ties that enable them to gain access to Irish potato in the form of gifts while those from non-producing areas seldom received Irish potato as gift. Field testimony by 36-year old Oku (producing area) woman living in the Mendong neighbourhood states that:
I always send many food items to the village to my family. In return, each time someone is coming to the city, they will also send me some Irish potato since this is the most common crop grown in my village and is very expensive here in town. This makes me to always have Irish potato even though I hardly buy. Even when my stock gets finished, I send money to my mom and she does everything to send me more potato. In this case she buys potato from people who also grow them as she does.

The third means of acquisition is through purchasing on spot (cash markets). Generally, more than 90% of households acknowledged that they purchase Irish potato from the urban market. The frequency of purchase varied from weekly to annually. More households from non-producing areas (41%) bought potato weekly while for those from non-producing areas, it was 38.9%. The majority of households bought potato monthly; 42.2% for indigenes from non-producing areas and 51.1% for origins from producing areas. This suggests that although households consumed potato, the frequency of purchase varied with the origin of the household. Also, the scale of purchase was analysed and it showed that 91.1% of people originating from non-producing households bought potato on retail with only 73.3% of households from producing areas. On the contrary, many more household (26.7%) from producing areas bought their potato from whole sales as against only 8.9% of households from non-producing areas. Again, this suggests that place of origin influences the procurement of potato and even the means of acquisition (Figure 15).

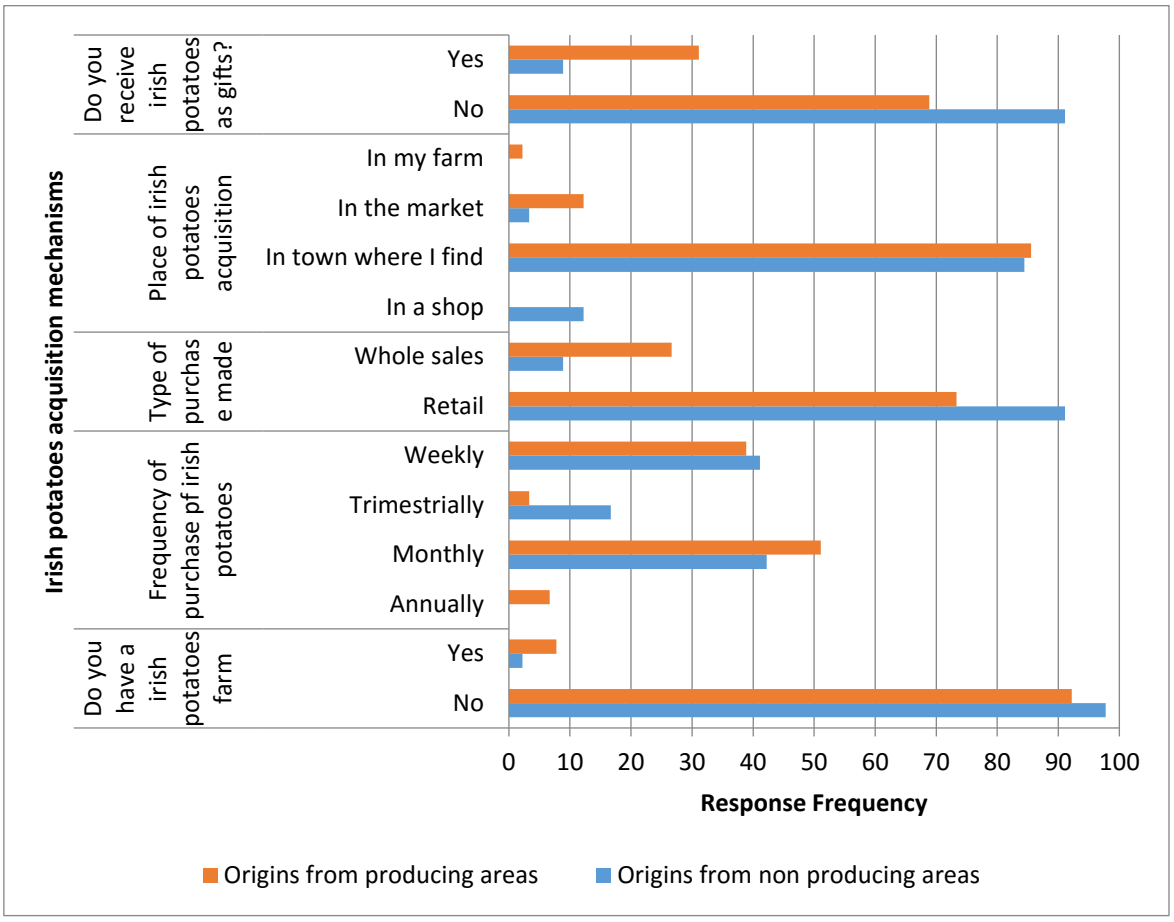


Figure 15: Irish potato acquisition mechanisms

This population, especially those from producing areas were more versed with distinguishing better varieties of Irish potato. Up to 91.1% of households from producing areas noted that they bought only varieties that they knew and 62.2% of households from non-producing areas. Whereas some used colour to distinguish these potato, others scraped the flesh to notice whether it was watery or not and the rest simply had special customers from who they bought potato. These methods assured the buyer that the product being purchased was of good quality. The increasing exposure and acculturation has been noted to have both

beneficial and deleterious changes in dietary habits, especially among groups living in urban areas (Alfa et al., 2012). In the case of this study, it has caused a necessary increase in social interaction and transfer of dietary habits across cultures and regions in Cameroon. On food acquisition, while in the cities, people from producing areas still show signs of remaining tight to their traditional food systems by the higher procurement of Irish potato in their households.

While household activities provide for partial subsistence, most families are not completely self-sufficient in providing for their Irish potato food needs. Therefore, they combine a range of strategies to satisfy their Irish potato needs like harvesting from their farms, purchasing and receiving as gifts, which are similar means that have been discussed by some authors (Ferris, 1997, Thonemann and Hausman, 2004). Social networks are also important in acquiring Irish potato as many more people from producing areas use this channels. Ngome Tata (2015) demonstrated the use of social relationships and organisations in securing livelihoods for poor people. This study has demonstrated this and shows that people use family members or go back to the places of origin to obtain potato. The results from this study have confirmed that the predisposition of tradition food systems and knowledge about foods influences food acquisition mechanisms (Haasova et al., 2016; Garcia and Leuthold, 2004).

Quantity of Irish potato procured and household preferred characteristics of Irish potato tubers: Generally, households from producing areas procured more Irish potato than those from non-producing areas. An evaluation showed that households from producing areas procured 31.8±27.3 Kg per month while those from non-producing areas only procured 10.8 ± 8.2 kg per month. This has been represented in a box plot as on Figure 16. The measuring units for Irish potato were bags or buckets of different volumes.

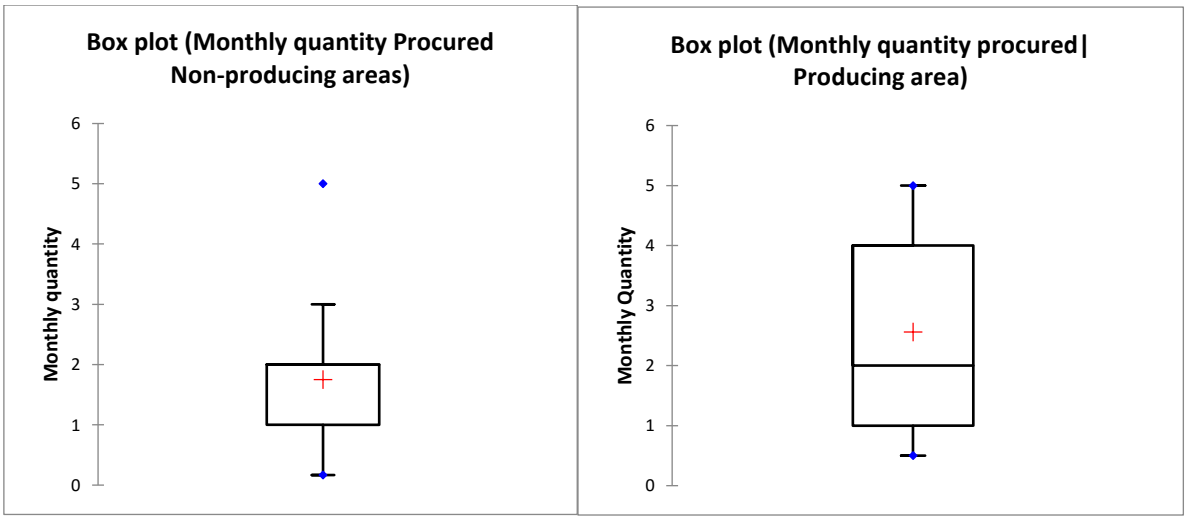


Figure 16: Potato use in households of producing and non-producing zones of Cameroon

Figure 18 shows that the use of Irish potato in households in both producing and non-producing zones was not uniform. Households from producing areas procured higher quantities of potato than households from non-producing areas. This means the individual food preferences, knowledge about foods and personal factors were what determined the acquisition and consumption of Irish potato. This tendency was also demonstrated on fruit

consumption in forest areas of Cameroon by Tata Ngome et al. (under review). Individual-reported food preferences and frequencies of food consumption have served as proxy measures of the current diet in consumer research and in nutritional epidemiology studies. The knowledge of household members on certain preferred characteristics of Irish potato tubers was also evaluated in this study. Here, respondents mentioned characteristics like traditional meal, easy digestion, dry and floury, tastes, eating habit and vitamins. Different households perceived these characteristics differently while nutritional value was very important for households form producing areas with 35.6% of households citing this. Eating habits (37.8%) appeared more important to people from consuming areas. These characteristics are presented in Table 15.

Table 15: Preferred characteristics from Irish potato tubers

Modality	**Variables**	**Origins from producing areas**	**Origins from non-producing areas**
Preference with respect to Irish potato (%)	Traditional meal	35.6	4.4
	Easy digestion	2.2	2.2
	Dry and floury	15.6	16.7
	Tastes	5.6	21.1
	Eating habit	0.0	37.8
	Vitamins	41.1	17.8
Household members that consume Irish potato most (%)	children	12.2	0.0
	Mother	0.0	2.2
	Everybody	87.8	97.8

Table 16 further suggests that for both categories of households, Irish potato was prepared for everybody in the house; 87.8% and 97.8% respectively for households from producing and non-producing areas. Further to this, 12.2% of households from producing areas demonstrated that Irish potato was consumed by children and a small portion of household from non-producing areas thought it was consumed by women. This analysis suggests that Irish potato meals were cherished by a majority of household member meaning that it is a food that can be easily valorised once the culinary practices are established. It also shows that households from producing areas have an old practice of using potato as children food and therefore even in the city, this practice has continued as could be demonstrated by this citation from a 24-year old mother originating from the Adamawa region, a mother of three children and running a household of 8 people.

When I do not have Irish potato in the house, it is hard for me to prepare food for my children. As I grew up, my mother thought me how to make many meals from Irish potato that can be highly cherished by children. I have already trained my children on these meals (fries, omelette, puree for the baby, roasted) and they like it a lot. Even when I prepare fufu for my husband and the others, I make sure I cook a potato meal for the children. They eat potato about four

times in a week but it is the principal food that they take to school to eat during break. Since potato is very expensive here in the city, I buy in bits to prepare only for the children. But in case we are chanced to have some potato from the village or my husband happens to buy in a large quantity, I can cook for everybody in the house.

Processing and Usage of Irish potato: Irish potato was used for cooking a variety of meals in the households. To appreciate the importance of these meals in each household, households were asked to list the meals that they prepared and it turned out that the meals cited in order of highest majority was potato hotpot (75.6%), fried potato (chips) (73.9%), boiled potato 38.3%, porridge potato 43.9%, pounded potato 19.4%, mashed potato balls 6.1% and Salad 4.4% (Figure 17).

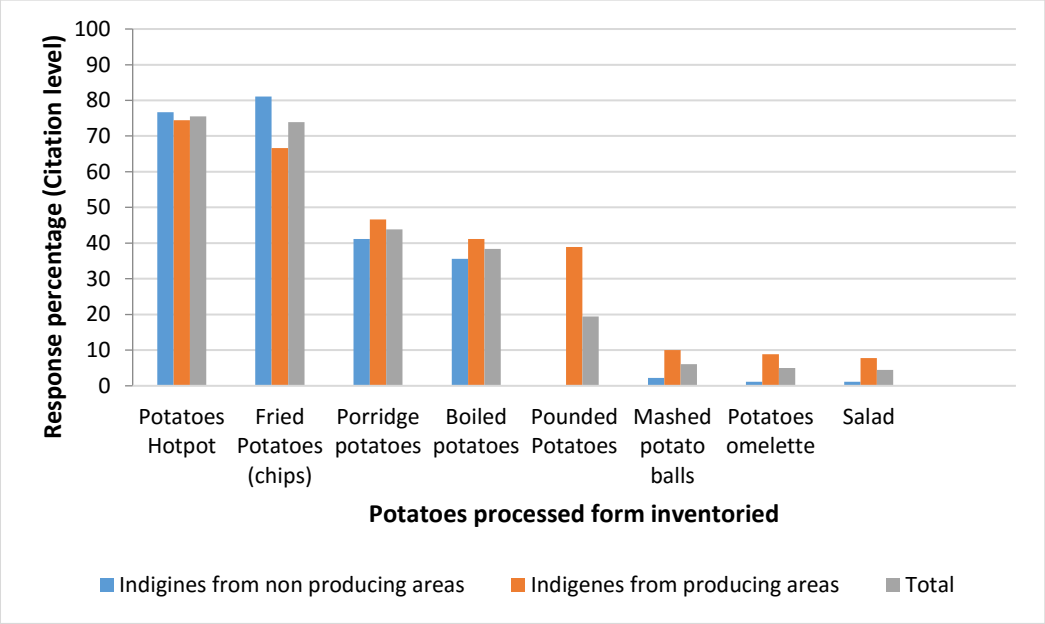


Figure 17: Processing and usage of Irish potato

Considering the two study categories of households, hot pot (74.4%), fried potato (chips) (66.7%), porridge potato (46.7%) and Pounded Potato 38.9% were most cited by respondents from the producing areas while respondents from non-producing areas cited fries 81.1%, potato hotpot 76.7%, boiled potato 35.6% and porridge potato 41.1%. This shows some extend of distinction between the use of potato as food in producing and non-producing areas. The description of these various meals and their socio-cultural contexts are presented in Table 16.

Table 16: Description of various meals and socio-cultural contexts

Meal	Description	Socio-cultural Perception
Boiled potato	These were fresh potato tubers boiled and eaten with a sauce, beans, or any vegetable	Ordinary meal taken during lunch or dinner. The amount of beef, fish or chicken in the sauce determines the quality of meal

Fried Potato (chips)	These are potato tubers that are peeled and cut into small slices and fried in oil. The chips are further cooked in different ways or eaten like that. This category also included potato that were boiled half ready and fried in hot oil.	Mostly breakfast and snack meal highly appreciated by children
Mashed potato balls	These are fresh potato tubers peeled, boiled and mashes sometimes with eggs. In other cases, they are mashed and mixed with raw eggs, made in small balls and fried again in hot oil	Not very common. In cases where the potato are mashed and mixed with boiled eggs, the meal is used as infant food and in the case where it is mashed and fried again, it is food during ceremony or snacks
Potato omelette	These fried potato chips mixed with eggs and fried again.	Luxury meals eaten in households of high standard or during treats for breakfast
Pounded Potato	Boiled potato mashed with beans, vegetables, spices and oil etc	Traditional meals in most producing areas of the Western highland zone
Porridge potato	Peeled potato cooked into a porridge	Meal prepared during hard times or food scarcity moments
Potato Hotpot	Peeled potato sometime half fried before cooking in lots of special spices, meat, carrot, green beans etc	Ceremonial and special occasion meals or prepared normally in rich households.
Salad	These peeled and boiled potato tubers are cut into small pieces and mixed into a salad	This is ceremonial food rarely prepared in households

Of these meals, we observe that potato traditional meals in the form of pounded potato and porridge were mostly prepared by households from producing areas. Therefore, people better appreciate other forms of cookery than the tradition form of pounded potato and beans. Other forms of potato cookery have been elaborated by Nain et al. (2018). In their manual, they have produced some standard appellations for potato dishes as used in restaurants following the Cameroonian cuisine. In addition to those cited above, these include grated potato cake, potato scotched egg, roasted potato, potato pepper soup, toasted potato, mashed potato and beans, pounded potato and vegetables or sauce and potato mould. These forms, although not reported by households in this study, may be incorporated into some of the appellations.

Results determination of the varietal characteristics, conservation and transformation processes, commercialization and consumption of Irish potato in the Adamawa

The fourth specific objective of this project was to determine the varietal characteristics, conservation and transformation processes, commercialization and consumption of Irish potato in the Adamawa region of Cameroun. Results show that Irish potato is an emergent culture with relatively small surface areas cultivated (0.25 to 1 ha). Main varieties cultivated are Cardinal, Bafoussam, Dosa, Panamera and Cipira in addition to others that are rarely cultivated. Those who transform Irish potato are mostly youths (66.66%). This activity is mainly carried out by women (61.54%) and the varieties used are Doza, Cipira, and Tubira among others. However, a majority of consumers (37.93%) ignore or are not concerned with the names of varieties used. Their choices are guided by the floury nature (56.52%), the taste (52.17%), size (17.39%), availability (13.04%) and the colour (13.04%).

Physico-chemical analysis showed that diameter and length of Panamera tubers are respectively greater (51.45 mm and 67.9 mm) than those of other cultivars. Dry matter content is between 19.70% and 29.88%. Only the Doza cultivar has dry matter greater than that obtained by Fauconnier and Delaplace (2004) i.e. 22.5%. The dry matter of Dosa, Cardinal and Panamera (respectively 29.88%; 21.58 and 20.76%) are all greater than 20% and thus are adapted to frying (Gallais and Bannerot, 1992). For pre-cooked potato, only Cipira and Bafoussam varieties stipped with 5% salt had enough water content (about 20%) after 1h and 2h stipping. For the Dosa variety, this content was obtained after the first stipping (30 mn). Sensory analysis revealed that chips samples of Cipira had higher scores than those of Dosa; thus Cipira variety was the most appreciated by consumers.

On the identification of different potato varieties, their conservation, transformation, commercialisation and consumption in the city of Ngaoundere, after going through the questionnaires administered to the various stakeholders of the potato value chain, it appears that potato is an emerging crop and the surface area cultivated is relatively low (0.25 to 1 ha); the varieties produced are principally Cardinal, Bafoussam, Dosa, Panamera and Cipira. Other varieties are equally cultivated in a residual manner. The principal constraint faced by the latter is rot during storage after harvest. Potato producers are individuals of both sexes, with 62.5% made up of men and 37.5% of women. These producers have a relatively average level of education with 35.71% secondary education and 35.71% primary education or not educated. The majority i.e. 80.64% have not received any formal agricultural training. The activity is carried out mainly by people originating from the West Region (35.48%) followed by the Foulbés (22.58%). Only 18.75% are members of producers' associations. The average experience is 10 years.

Some varieties produced include: Dosa in the majority (46.87%); Cipira, Tubira, Jacob. Other varieties include Maffo, Diamant, Spinta, Cardinal, Mondial, Bafoussam and Bambui. They equally produce varieties whose names they do not know, but are only interested in their origin which is generally the West and North-West Regions. The majority of these producers (77.77%) store their harvested produce so as to consume or sell them later on. They use many storage techniques with the principal one being that in which the tubers are spread on the floor (66.66%) followed by the storage in bags, underground, on straw or sawdust. Almost all

producers (91.66%) encounter losses that amount to 11% on average. In order to limit these losses, the producers adopt certain behaviours with the main one being the regular selection of attacked tubers (38.88% of producers) followed by the reduction in production (27.77%) for fast consumption/sale. Production constraints are numerous with the principal ones being small storage space (57.14%) and/or the absence of storage material (21.43%), theft (14.28%) as well as rot and attack by insects. The solution clues suggested by producers are numerous. Some include:

- grouping of producers in CIGs or cooperatives;
- creation of large storage areas;
- support or subventions by the government;
- chemical treatment of harvested produce;
- limiting the use of chemical fertilizers.

For processing, transformers are mainly grouped in the category of youths (66.66%). This activity is principally carried out by women (61.54%) whose level of education is relatively high (secondary: 45.45% and university: 40.91%). They mainly evolve alone. Only 11.11% of these transformers belong to transformers' associations. The average experience in the activity is 10 years with a majority (64.28%) having more than 10 years of experience. There exists no industrial transformation. It is done mainly by restaurant owners. The varieties used include: Cipira, Tubira, Jacob among others. However, the majority of transformers (75%) ignore the names of the varieties they use or are not concerned about it. The reasons that guide their choices are principally the taste (81.25%), followed by the starchy nature and then the size. The purchase frequency varies daily (12.5%), twice per week (20%), weekly (20%), and occasionally (20%). The factors that influence purchase or introduction of potatoes in their menus include the market price (64%), customer demand (60%) and the availability of potatoes on the market (40%). Table 17 presents the transformed products identified during the survey.

Table 17: Different transformed potato products in Ngaoundere

Products	Processes	Rate of usage of product (%)
Fries	Sliced into strands and cooked in an oil bath	70%
Chips	Fine fried and crackling rondelles	30%
Stew	Composed of potatoes, meat and cooked in a sauce	30%
Fried	Mixture of potato and vegetables cooked on high heat	20%
Pounded	Potatoes, beans, raw palm oil, cooked and pounded	20%
Porridge	Potatoes, oil, groundnut paste, smoked fish cooked all together	15%
Vapour	Potatoes cooked with water or vapour	10%
Flour	Powder obtained after drying and milling	10%

Fufu	Potato flour cooked in hot water	10%
Juice	Liquid part of potatoes obtained by squeezing	5%
Soup	Extract obtained after cooking potatoes and vegetables	5%
Mash potatoes	Grounded potato and vegetable porridge	15%
Cake	Pastry made from potato flour	20%
Starch	White organic substance made from potato	5%
Macédoine	Potatoes and vegetables sliced in small pieces	5%

Table 21 presents the products identified during the survey with their frequency of occurrence at transformer level. Potato is also used in the treatment of gastric ulcers using potato juice; in cosmetics with beauty masks using potato oil.

On consumption, potato consumers are of almost all social backgrounds. Purchase frequencies vary daily (3.7%), weekly (7.4%), monthly (55.55%) and occasionally (26.92%). The factors that influence purchase or introduction of potatoes in consumers' menu include the market price (69.23%), the revenue (53.84%), the availability of potatoes on the market (50%) and the distance to the point of sale (26.92%). The varieties used include: Doza, Cipira, Tubira. However, a good number of consumers (37.93%) ignore the names of the varieties they use or are not concerned about it. The reasons that guide their choice are principally the starchy character (56.52%), the taste (52.17%), the size (17.39%), the availability (13.04%) and the colour (13.04%). The main dishes prepared with potatoes include fries/chips, stew/fried, pounded/porridge and steamed potatoes. The choice of varieties depends on the taste, colour, nutritive value, size, purchase price, resistance to rot, starchy nature and the availability.

Potato commercialisation is an activity in which women represent the majority (60.42%). These sellers have a relatively low level of education with 31.82% having received no education and 36.36% with primary education. Only 11.12% are members of sellers' associations. Their average experience in the activity is 10 years. The varieties sold include: Doza as majority (33.33%), Cipira (17.77%) and many other varieties whose names they do not know. These sellers acquire their goods from different sources with the principal ones being the local market (37.77%) and the West and North-West Regions (40%). Some sell their personal produce and others get it directly from producers' farms. Even though the majority of sellers (75.55%) are able to sell out all their goods, certain are unable to. What remains is either consumed (55.55%) or kept as seeds (44.44%). Almost all sellers (87.5%) register their storage losses. In order to limit these losses, sellers have the habit of ameliorating their storage conditions, selling their daily remaining goods at reduced prices and consuming some in the family. A high demand in potato is observed during festive periods principally during the Ramadan period. The potatoes are sold in different sets namely:

- in piles with the price ranging from 200 FCFA to 1000 FCFA;

- in buckets with the price ranging from 4000 FCFA to 6000 FCFA;
- in bags with the price varying with respect to seasons.

Sellers are faced with a good number of constraints, the most important one being the high price of potatoes out of season, followed by the irregularity at the level of suppliers, then storage problems and lastly consumer scarcity. During the survey, the available potato varieties were used to go on with the work (Figure 18).

a: Potatoes conditionned in a carton **b: Pile of potatoes for sale**

Figure 18: Illustrative photos of potatoes for sale

On physico-chemical characterization of fresh potatoes, visual description showed that the sampled potatoes were yellow and red in colour (Table 22). They were dotted with brown spots for yellow potatoes and red spots for red potatoes. The shapes of the potatoes vary: oval, long and round. The average size varies with variety. The visual description of the different potato varieties are presented on Table 18.

Table 18: Visual description of the analysed potatoes

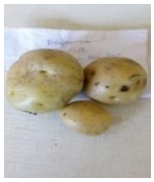
Varieties Parameters	**Cardinal**	**Bafoussam**	**Dosa**	**Panamera**	**Cipira**
Photo					
Potato colour	Ox blood	Yellow	Yellow	Yellow	Yellow
Spots	Small white spots	Less regular brown spots	Small brown spots	Small brown spots	Large dark spots
Forms	Round and spherical	Round, oval and long	Round and oval	Spherical, oval and round	Spherical, oval and long

Table 19 presents the results of the physico-chemical analysis of the potatoes. The tuber diameter and length of Panamera are respectively more (51.45 mm and 67.9 mm) than those of other cultivars. The dry matter content (DM) varies between 19.70 and 29.88 as on this table.

Table 19: Physico-chemical characteristics of the potato varieties under study

Varieties **Parameters**	**Cardinal**	**Bafoussam**	**Dosa**	**Panamera**	**Cipira**
Mass	53.62	87.28	75.86	105.615	100.88
Number of eyes	9.85	7.7	7.50	9	8.80
Length	49.8	62.9	55.15	67.9	61.65
Diameter	42	48.3	47.7	51.45	50.15
Median diameter	44.4	52.57	50.01	55.93	53.60
Sphericity	0.90	0.86	0.91	0.83	0.88
Water content	78.42%	80.30%	70.12%	79.24%	79.82%
Dry soluble extract	4.867	5.57	7.50	4.80	6.00
pH	/	5.86	6.28	/	5.78
Pulp yield	76.64%	78.61%	78.54%	81.56%	80.59%

Only the Doza cultivar has a DM content superior to that obtained by Fauconnier and Delaplace (2004), i.e. 22.5%. Doza, Cardinal and Panamera have DM contents (29.88%, 21.58% and 20.76% respectively) superior to 20% and as such adapt to frying (Gallais et Bannerot, 1992). The result of the weighed masses shows that the Panamera cultivar is the richest in pulp (81.56%) followed by those of Cipira (78.61%) and Doza (78.54%). The Doza, Cipira and Bafoussam varieties have soluble dry extracts (7,5°bri; 6,00°brix and 5,57°brix respectively) higher than those of the other cultivars under analysis. This result shows that they are apt to cooking with water or with vapour. From these results, it can be observed that the Doza cultivar is adapted for cooking in water, vapour, as well as for frying. While Cipira and Bafoussam are apt for cooking with water and vapour, Panamera and Cardinal are apt for frying. The analysis of potato conservation looking at the production of poached potatoes, Figures 19 and 20 give the dry matter content of the various samples with respect to their solute percentage and soaking duration.

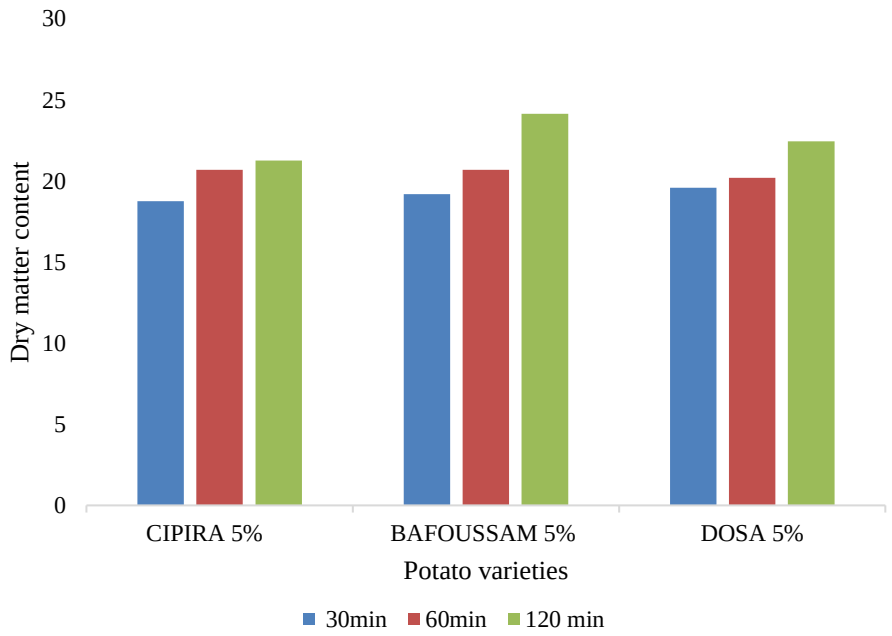


Figure 19: Dry matter content of the potato slices soaked in a solute solution of 5%

According to the results obtained (Figure 25), only the Cipira and Bafoussam varieties soaked in 5% salt solution had sufficient water content (more or less 20%) for poaching after 1 hour and 2 hours of soaking.

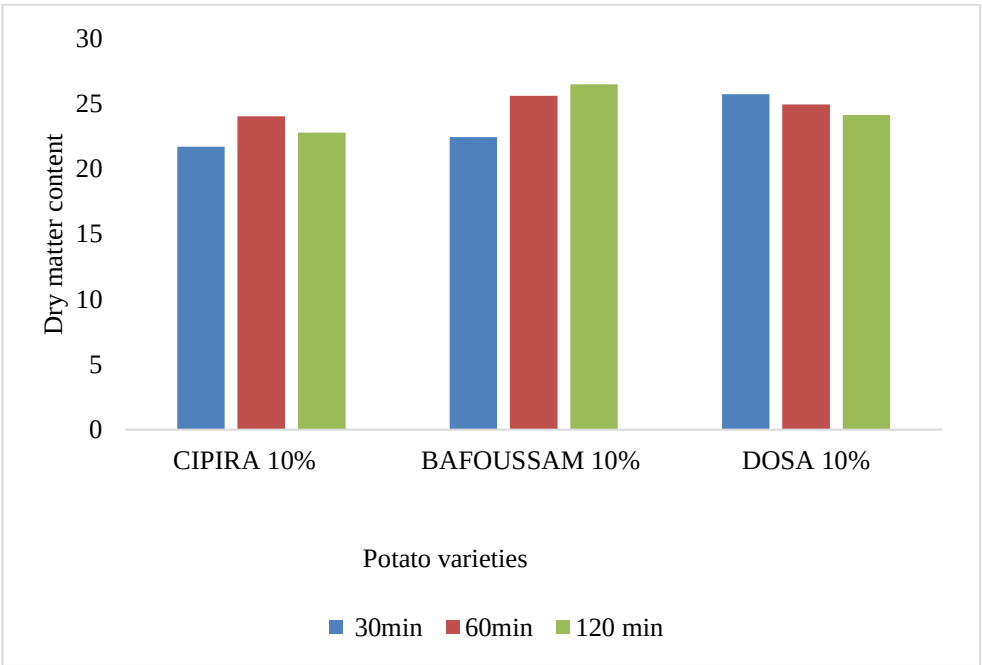


Figure 20: Dry matter content of the potato slices soaked in a solute solution of 10%

As for the Dosa variety, this percentage was obtained as from the first soaking time (30 mins). These results are in accordance with those of Fauconnier and Delaplace (2004) that showed that dry matter of poached potatoes should have water content between 20 and 23%. Also, the results obtained after soaking at 10% show that all pre-treated varieties have water

contents greater than 20%. Figure 26 presents the general preference of the consumer panel (Figure 21).

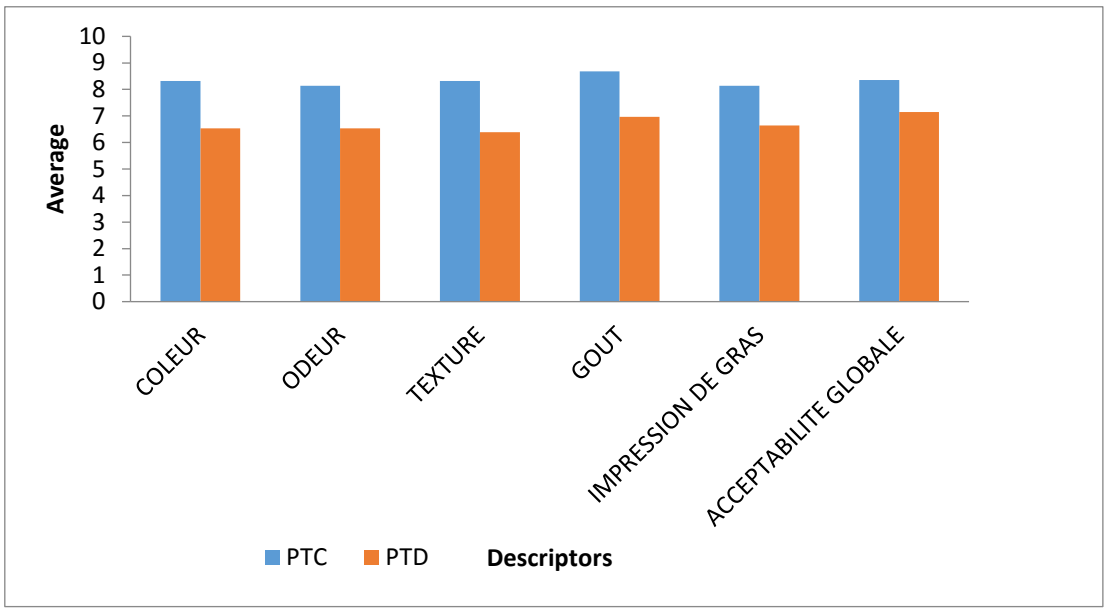


Figure 21: Average sensory characteristics with respect to the samples

In this figure, it can be observed that potato chips from Cipira (PTC) had scores higher than those from Doza according to the various descriptive characteristics. The visual presentation of the sensory analysis is presented in Figure 22.

a: Tasting of potato chips in Ngoundere **b : Packaged chips** **c: Frying of chips**

Figure 22: Illustrative photos for sensory analysis

Results on the analysis of supply and distribution systems of food prepared out of the home in big cities: the case of potato in Yaounde

The fifth specific objective was to analyse the procurement and consumption systems of food prepared out of home in big cities like Yaounde. The reality is that most people of all social strata in urban areas of Yaounde consume food prepared out of their homes. It was revealed that out of home consumption of potato and its commercialization have been gaining popularity for decades in Cameroon; potato is becoming an accompaniment dish of choice in restaurants of big cities like Yaounde, notably for households that do not have enough time to prepare food for many. This study revealed that clients of this product are a mix from potato producing and non-producing zones, motivated by shared feeding habits thanks to

cultural exchanges and moderate prices in restaurants. For our study on the consumption of potatoes outside the household, several types of restaurants were identified. These are African-style restaurants (46%), Street vendors/Road-side (28.80%), followed by Western-style restaurants (10.70%), very few hotels (2.30%) and supermarkets (2.80%). Other statistics already show that among the 215 respondents, this study shows that there was a predominance of the male sex (64%) over the female sex (36%), among others 61.6% single, 33.2% married and monogamous, 1.9% married polygamous, a tiny part divorced (0.5%) as well as widowed (1.9%); in general a clientele mainly made up of singles (61.6%) and monogamous married (33%), a few widowers (3%) and polygamous married (2%).

The majority of customers were heads of household (51.9%) and other members (48.1%). The population was full of Cameroon's large ethnic groups of both sexes such as Fang-Beti (45%; 46%), followed by Grass Fields (42%; 40%), Sudano-Sahelian (7%; 5%) and finally the Sawa (6%; 9%). The majority of the clientele was made up of young people. With regard to the age of clients, the majority were in the [28-33] range (30.40%), followed by young people in [22-27] (23.40%) and people whose ages ranged from [34-39] (14.80%) and [40-45] (14.00%), an older age group 52 years and over (4.30%); the average age of the clientele was 33 years, indicating that the clientele was practically young (Table 20). The clientele is mainly made up of intellectuals: 41% (university), 28% (high school) and 22% (junior high school) whose average size was 6 people since we had a large part of the clientele whose household size was less than 5 people (54%), followed by clients with a household size of 5-8 people (36%), then households of 9-11 people (6%) and finally with persons whose household size was more than 11 people (4%).

Table 20: Socio-demographic analysis of non-household potato consumers.

Distribution of restaurants by type			
Description of supply locations by customer	**Description**	**Number**	**%**
	African- type restaurant	99	46%
	Western- type restaurant	23	10,70%
	Hotel restaurant	5	2,30%
	Street seller/ « Tourne- dos »	62	28,80%
	Supermarket/bakery	6	2,80%
	Snack-bar	18	8,40%
	other (specify)	2	0,90%
	Total	**215**	**100%**
Distribution of potato customers by gender			
Sex		**Number**	**%**
	Male	138	64,2%
	Female	77	%
	Total	**215**	**100.0%**
Distribution of customers by matrimonial status			
Stat matrimonial status		**Number**	**%**
	Single	130	61,6%
	Married monogamous	70	33,2%
	Married polygamous	4	1,9%

	Divorced	1	0,5%
	widower/widow	6	2,8%
	No answers	4	1,9%
	Total	215	100.0%
Distribution of customers by position in the household			
		Number	**%**
Position in the household	Head	110	51,9%
	No Households	102	48,1%
	No answers	3	1,4%
	Total	215	100.0%
Distribution of customers by ethnic group			
		Male	**Female**
Origin of customers / Sex	Fang-Béti	45%	46%
	Grass Fields	42%	40%
	Sawa	6%	9%
	Soudano-Sahélien	7%	5%
	Total	100%	100%
Distribution of customers by age range			
		Numbers	**%**
Age range (year-old)	≤21 year-old	16	7,50%
	[22-27]	50	23,40%
	[28-33]	65	30,40%
	[34-39]	32	14,80%
	[40-45]	30	14,00%
	[46-51]	13	6,20%
Total	52 year and more	9	4,30%
Distribution of customers by socio professional category			
		Numbers	%
Level of education	No level	3	1,40%
	alphabetisation/koranic	1	0,50%
	primarily	18	8,00%
	secondary undergraduate cycle	46	21,60%
	Secondary upper cycle	59	27,70%
	university	88	40,80%
	Total	**215**	**100,00%**
Distribution of customers by household size			
Size of the household		**Numbers**	**%**
	Less than 5 persons	116	54%
	5-8 persons	78	36%
	9- 11 persons	13	6%
	More than 11 persons	8	4%
	Total	215	100%

The first part of the analysis dwelled on the identification of prepared dishes and accessibility of dishes by customer. The first observation was that it was men ate more meals outside the household than women in African-style restaurants; men (49.30%) and women (40.30%). In restaurants called roadside restaurants, there are more women (36.40%) than men (24.60%). Very few women consumed food in Western-style restaurants (6.50%) unlike men (13.00%), as well as in snack bars where women were more numerous (9.10%) than men (8.00%). The consumption of the dishes is varied here, due to the ethnic groups represented, which must influence eating habits.

According to Figure 28, Africa type restaurants dominated in the inventory with 46% of all restaurants inventoried followed by who made up 29%. Based on these results, the modalities showed that in general, most consumers in restaurants were women, it is true that of the seven modalities there are only three that are fully represented by men, but this is not a very large percentage gap. Chi-square tests of the types of restaurants frequented by gender show that the ddl value of Pearson's Chi-square is 9.939a, the ddl is 6 and an asymptotic (bi-lateral) significance of 0.127; a likelihood ratio of 10.6, its ddl of 6 and asymptotic (bi-lateral) significance of 0.102 and finally its linear to linear association whose value is 4.55 and ddl of 1 asymptotic (bi-lateral) significance of 0.033; a 6 cells (42.9%) have a theoretical number of less than 5 (Figure 23) .

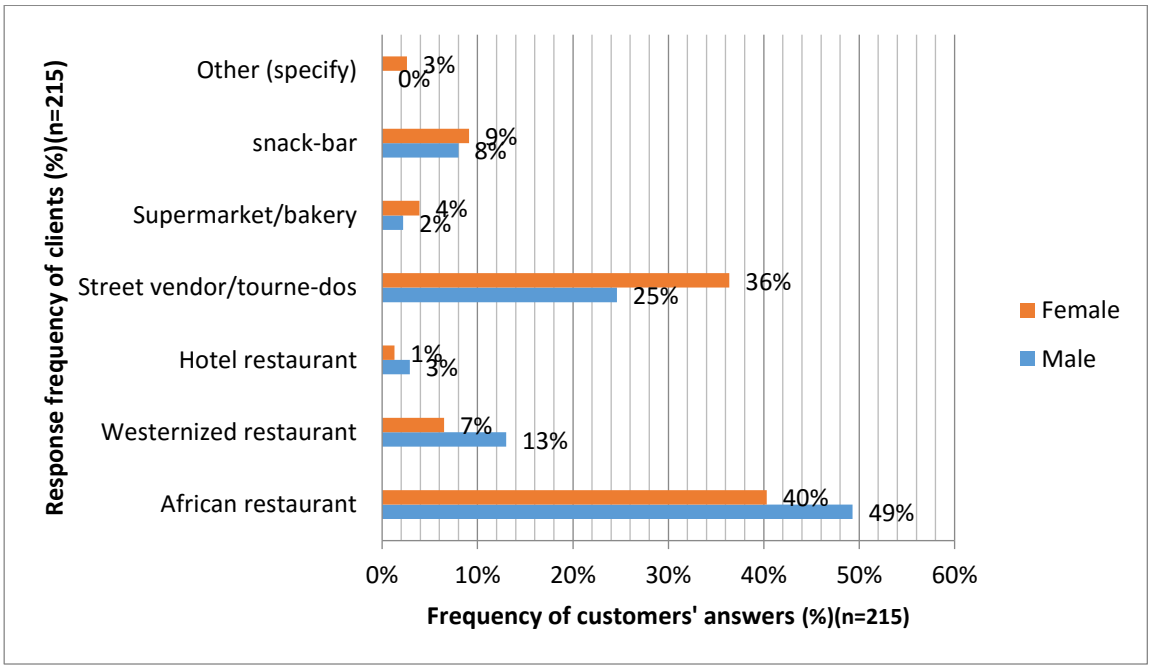


Figure 23: Types of restaurant visited per gender

Regarding restaurant labour force, the minimum theoretical number of employees is 0.72. The most popular potato-based dish in Yaounde I subdivision is potato chips (54%), followed by potato stir-fries (25%), potato mashed potatoes (13%) and potato broth. Very few are dishes such as potato steam (1%), frozen potatoes (1%), potato stew (1%) and chips (1%). As far as the Yaounde II subdivision is concerned, potato chips are still in first place (49%), but

the second place is potato pie (22%) followed by stewed potatoes (21%); mashed potatoes appear here but in a small quantity (2%).

Figure 24 shows the different restaurants in our sample according to the age groups of the customers. It shows that customers generally like to frequent African-style restaurants and road side restaurants ("*tourne-dos*"), not only because of the types of food they serve, the dishes they know and which are part of their food habits, but also because of the price of potato dishes which are for some people affordable. This shows that African-style roadside restaurants and restaurants are the most visited places by consumers, although the service offered to customers is not equal in all these types of restaurants. Hotel restaurants are not really represented in this study. For some customers, these restaurants are frequented to consume other dishes from elsewhere and this is not also at a price that is accessible to all social classes. In the age groups 52 years and over, consumers in African-style restaurants is high (56%) followed by roadside restaurants (22%). It should be noted that for the age groups[46-51], it is the backstand that takes precedence (54%) over the African type (38%); it is the same representation that is made with clients whose age group is between[40-45] (37% ; 36%).

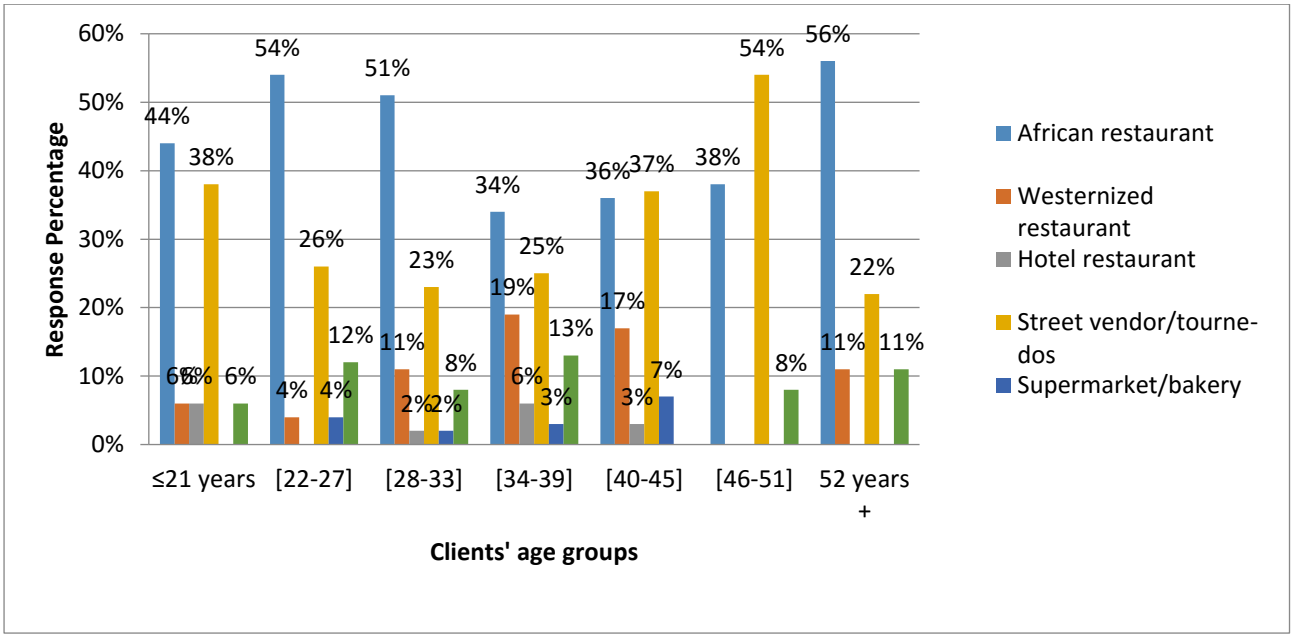


Figure 24: Types of restaurants visited by different age groups of customers

Consumers in urban areas prefer to buy cooked food in the informal sector most of the time because of the accessible prices and proximity of the product (Romanik, 2005). The dishes offered to customers are not always equally accessible to everyone, since our study showed that a large majority of customers find the price of potato dishes affordable (85.5%). The dishes offered to customers are not always as affordable for everyone as our study showed that a large majority of customers find the price of potato dishes affordable (85.5%) against a minority who consider that prices are not affordable (14.50%). Thus, the consumption of potato dishes per month is done at a different frequency by customers in restaurants. Only a large majority consume potatoes less than twice a month (47.0%), then 2-4 times (34.90%),

then 5-7 times (12.10%), few customers consume potatoes either 8-10 times (4.00%) and more than 11 times (2.00%) (Figure 25).

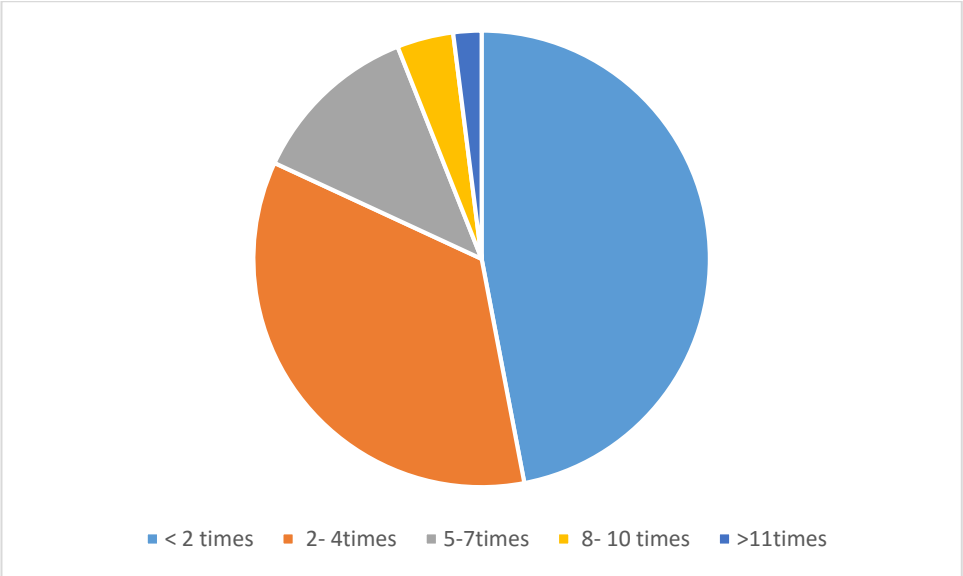


Figure 26: Frequency of purchase of potato by-products by customers over a month.

Figure 27 presents a cross-referenced evaluation of food price appreciations by type of restaurant visited by customers. What is most likely is that some customers (45.20%) find that the prices of dishes made in African-style restaurants are not affordable for everyone, compared to another group of customers who found the price affordable (46.40%). This figure also shows that in restaurants commonly known as roadside restaurants, few customers (28.40%) found the prices affordable against a majority of customers who found them rather high (29.00%). In snack bars, more customers found the prices of dishes unaffordable (16.10%) and a minority who had no problem with prices (7.10%).

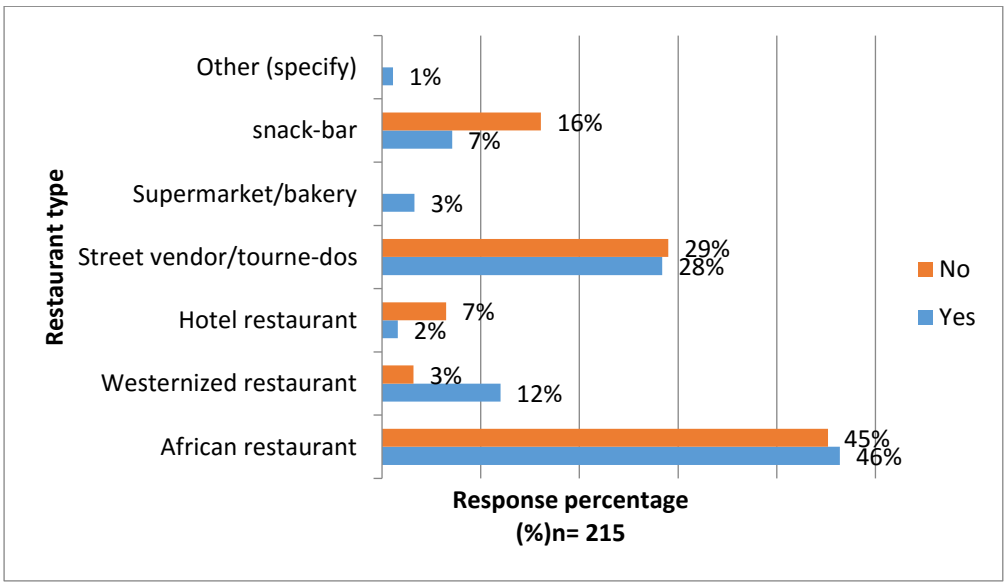


Figure 27: Price appreciation of dishes by customers in the different types of restaurants.

Substitution in the absence of potatoes dishes in restaurants

Figure 28 shows the different substitutional dishes consumed by customers in the absence of potato dishes. Thus, plantain fries (46%) are the most popular in the absence of potatoes, followed by rice (12.1%), macabo (4.2%), crushed plantain (3.3%), plantain mixed with peanuts (0.5%), spaghetti (2.3%), Sanga (0.5%), Okok manioc (0.5%), Koki (0.5%), Taro (1.4%), steamed plantain (1.4%), sweet potato (0.9%), bread (1.4%), ndolé (0.5%), manioc (1.4%), macabo grated with peanut sauce and okra (0.5%), yam (0.5%), Eru (1.4%), corn couscous (3.7%), carrots (0.5%), manioc stick and Ndomba (0.5%).

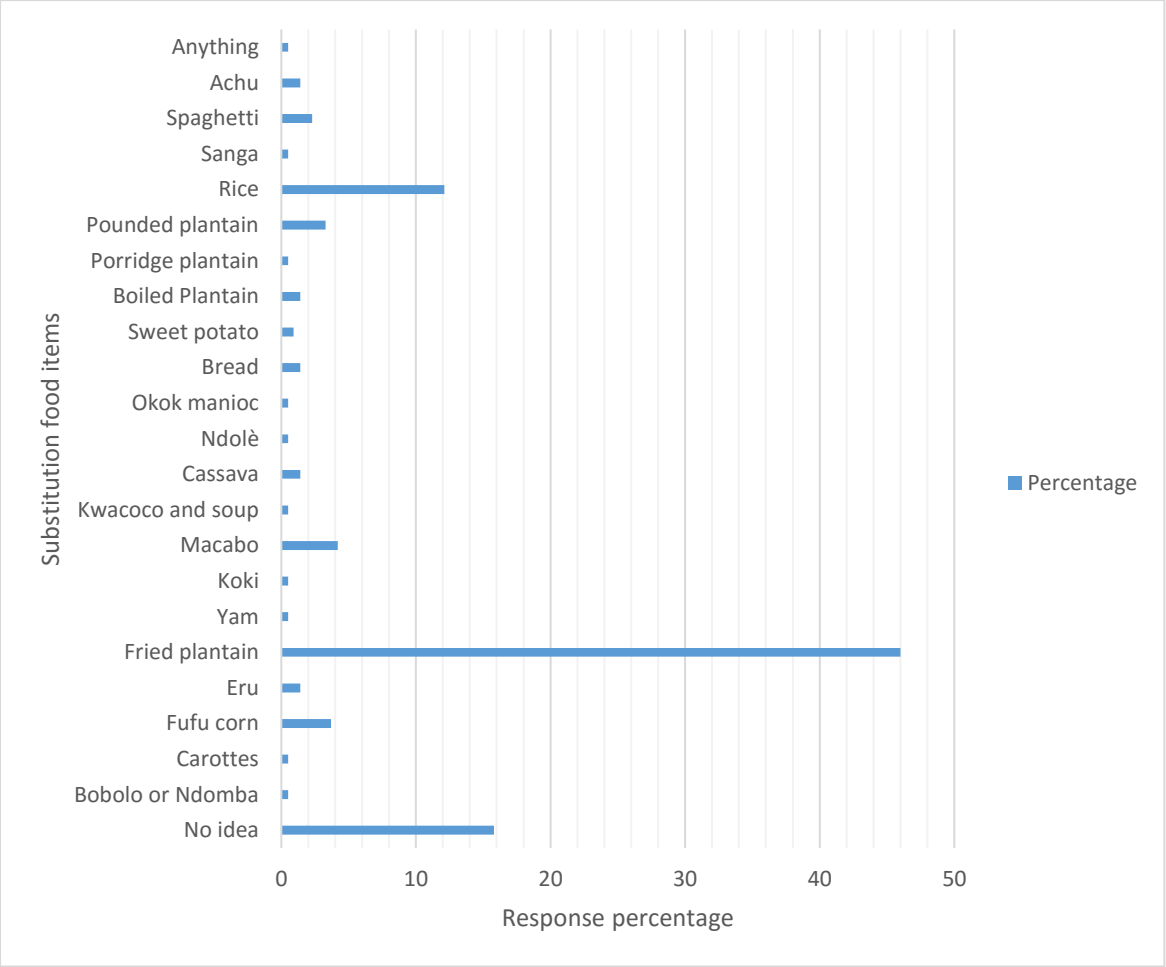


Figure 28: **Different alternatives to potatoes**

It should also be noted that during this study, clients were able to report problems with cooked dishes, first of all, a large majority of clients found no problems with the dishes served (78.5%) against a minority who found that either the dishes served were of poor quality (11.1%), i.e. poor cooking (5.3%), the dish served is wet (1.7%), the blackening of potatoes (1.3%), rarity of the product sometimes in restaurants (0.9%) and the cost of the product or dish (0.8%). To overcome these problems of quality of food consumed in restaurants, these same customers have proposed solutions. Already, the vast majority who do not really have any problems and therefore do not propose any solutions (87.4%), followed by a small clientele who offer awareness on quality and the varieties to market (5.1%), improve the quality of potato cooking either through practical training (4.2%), or have quality potatoes on

the market (2.3%). Figure 33 shows the types of restaurants frequented by clients according to their marital status. As a result, divorced people (100%), polygamous married couples (100%), frequent all the roadside restaurants, while a small handful of monogamous (27%) and single (28%) married people follow them. As for African-style restaurants, many widowed customers like to frequent these places (80%), as well as some single people (47%), followed by monogamous married couples (44%). In snack bars, a small proportion of widowers attend (20%), as well as monogamous married couples (9%) and single people (9%). Unfortunately, Western-style restaurants are not in demand (monogamous (14%) and single (10%) marriages, as well as supermarkets (monogamous marriages 6%, single 2%) and hotel restaurants (single 3%, monogamous marriages 2%). According to the Chi-square tests, Pearson's Chi-square demonstrates the value of 25.252a against a ddl of 24, hence the asymptotic (bilateral) significance of 0.392, the likelihood ratio of 25.914, ddl 24 and an asymptotic (bilateral) significance of 0.358. A linear observation association per linear with a value of 0.44, a ddl of 1 and an asymptotic (bilateral) significance of 0.507 with a number of valid observations. According to the Chi-square tests, Pearson's Chi-square demonstrates the value of 25.252a against a ddl of 24, hence the asymptotic (bilateral) significance of 0.392, the likelihood ratio of 25.914, ddl 24 and an asymptotic (bilateral) significance of 0.358. A linear to linear observation association with a value of 0.44, a ddl of 1 and an asymptotic (bilateral) significance of 0.507 with a valid number of observations of 211; has 27 cells (77.1%) have a theoretical number of less than 5. The minimum theoretical number of employees is 0.01.

As regards the reasons for consumption of potatoes in restaurants by customers, Figure 29 summarizes several that have been listed, some based on the characteristics of this dish and the most common was the nutritional intake of starch (22.70%), then because of the taste that customers believe is better and the colour (20.50%). For others it is because the potato is digestible (18.60%), for some it is because of the taste of the potato that they consider better (16.80%), for other customers it is just because they see others consume where they follow (15.80%), but very few consume because of their eating habits (5.10%) and good cooking (0.50%).

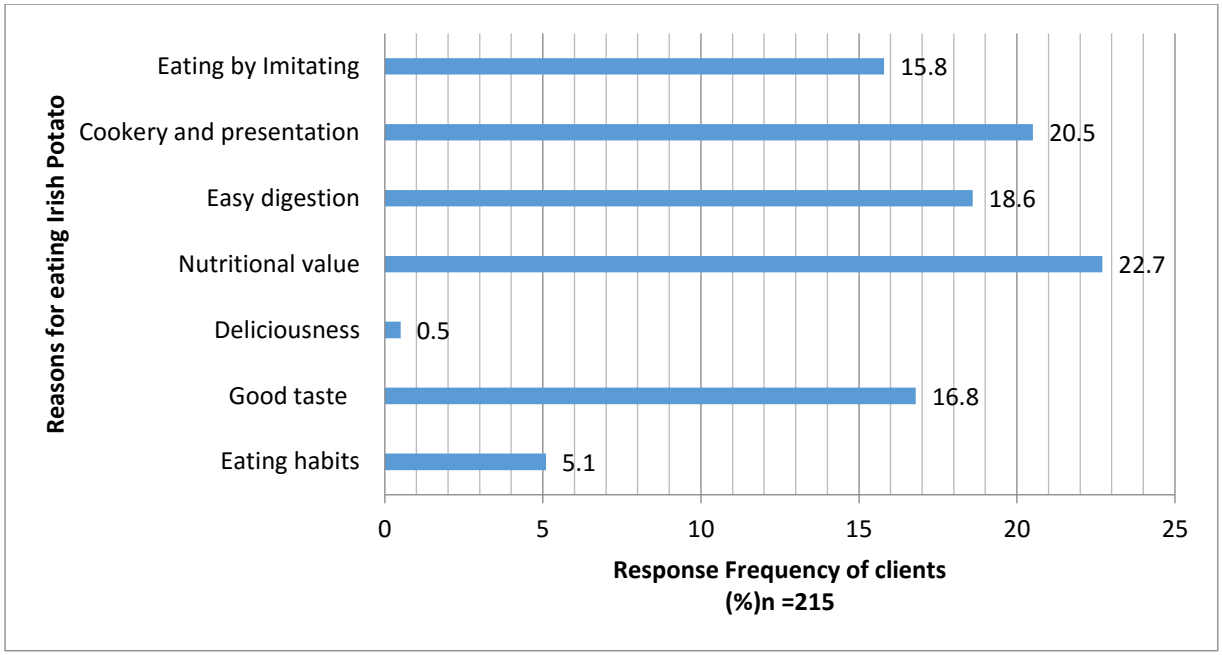


Figure 29: Reasons for potato consumption in restaurants

Figure 30 shows that the dish made of potatoes in restaurants or places where customers are used to eating is not always accessible to everyone, i.e. at a high price. There are many reasons for this, such as: either the price of the potato dish is high (11.60%) or the price of the dish depends on the quality of the potato (9.80%), or depends on the period of abundance (1.90%) or there is an absence of the potato (0.90%). However, a large majority have no idea how expensive the potato dish is in restaurants (75.80%).

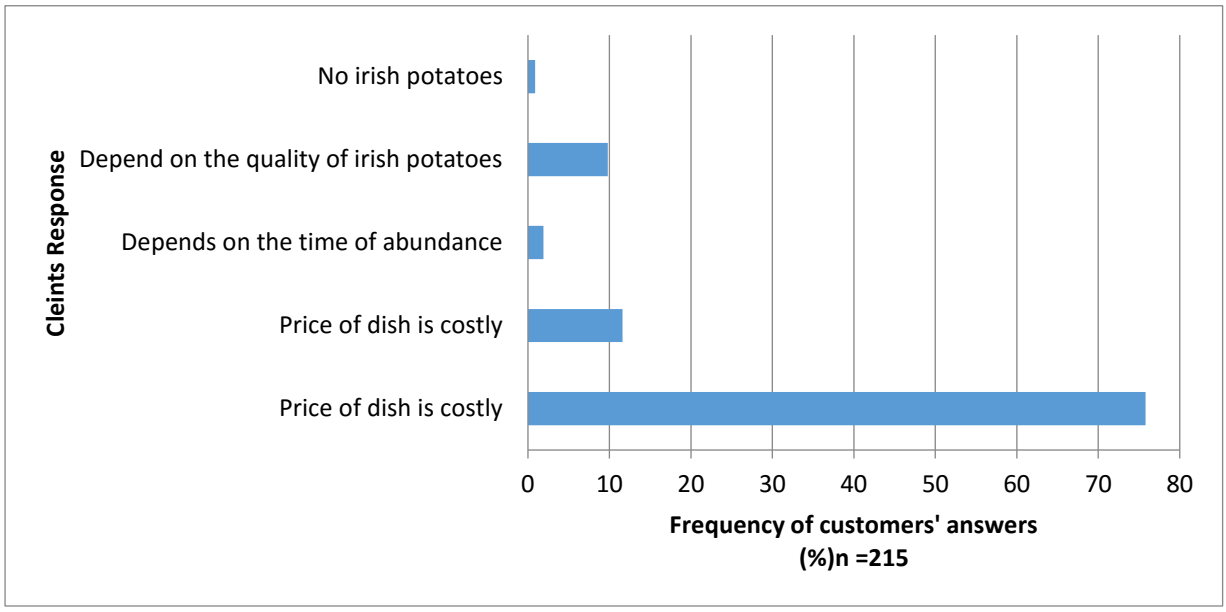


Figure 30: Reasons for the inaccessibility of ready- made potato dishes.

From Figure 31, after a study on the reasons for the variation in the potato dishes offered to customers, it emerged first of all that the price of the proposed dish depends on the accompaniment (meat or fish) (21.40%), that prices vary according to the seasons (17.70%), either depends on the purchase price of the potato (13.70%) or the price also varies according

to the location of the restaurant and the form in which the potato is marketed (8.60%). For very few customers, prices do not vary (2.40%) and also depends on the quantity requested by the customer (1.90%); Nevertheless, a large majority do not know the reasons why the dish varies since they do not pay attention (33.90%).

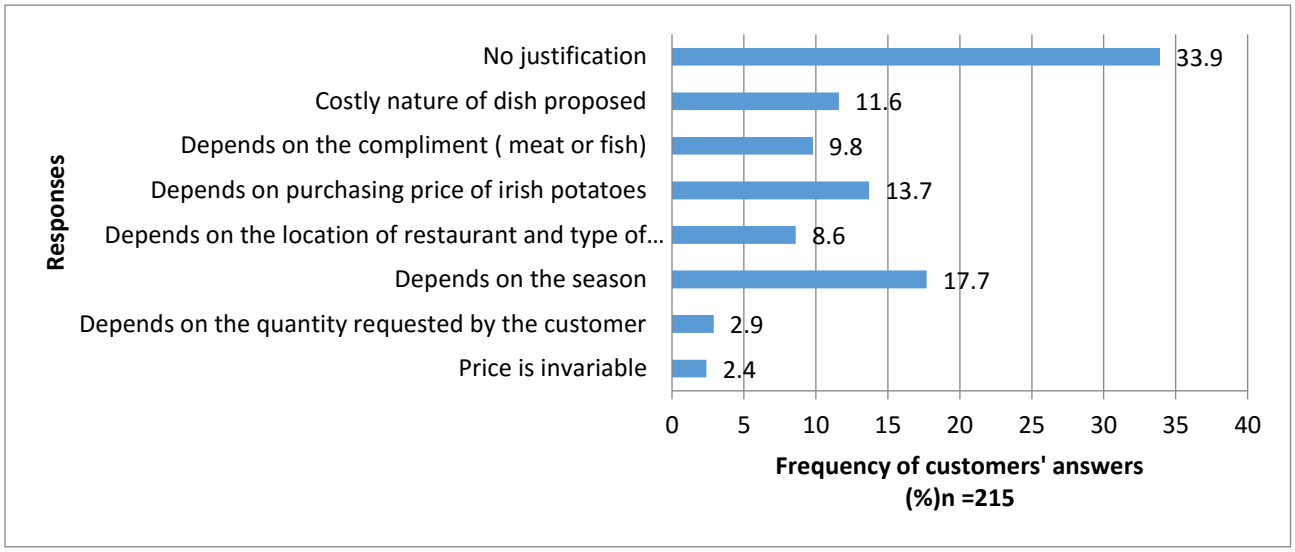


Figure 31: Reasons for the variation in prices of potato dishes in restaurants.

Discussion

The food situation remains fragile according to FAO statistics for the various countries in the Region, with the exception of Côte d'Ivoire, Cameroon and Gabon, where food availability is significantly below 2400 calories/inhabitant/day (Bricas et al., 1991, Debru et al., 2017). The city of Yaounde is one of the most populated urban areas and abounds in a multitude of restaurants. Urbanization and higher incomes are associated with changes in diets, which are reflected in trade parameters. The main objective was to examine out of home potato consumption using the marketing approach. This approach is mainly based on four pillars: product, price, place and promotion. The literature shows that marketing ensures sustainable success of a product in a given market. The thought according to which "any offer finds its outlets" by Jean-Baptiste Say, who belongs to the classical school of economics, seems to be over. In fact, demand or customers increasingly have access to information such as caloric intake and the bromatology of the potato. Our results of the mix-marketing analysis of non-household consumption of potatoes in urban areas show that fried potato is the most consumed form. This form is easily prepared and takes less time than stew for example, which helps to reduce customers waiting time. They can also be crunchy and are well preserved depending on the cooking degree. Van de Laer et al. (2001) explain that in the processing market, the percentage of dry matter and frying colour are decisive factors in the choice of fried products. In fact, the percentage of dry matter impacts the texture while the frying colour influences on their aspect.

The average price of potato derivatives is 1,200 FCFA. It is important to emphasize that potato is mainly a complement. Also, the price is higher when beef is used instead of fish. The lowest prices correspond to potato pounded with beans; priced at 500 FCFA. Pounded potatoes are considered by some to be stodgy and strength laborers love them as well as those on a low budget. As for the place, the most popular type of restaurant is the African-style with more than 40%. This is due to the eating habits of customers who make a link with what is consumed at home. The next is road side restaurants (tourney-dos) with more than 26%. This is the fast food market with pre-cooked and even cooked food to decongest the queue. The fixed price is likely to enable restaurant owners to recover the various expenses and structural costs related to the restaurant activity; and thus, contributes to the results of different restaurants, given its strong presence in proposed menus. From a concomitant analysis of price and place, it appears that the quality / price ratio is low where the low-quality estimated dishes have the lowest prices; pounded potato with beans in this case are mostly distributed by street vendors and high prices related to dishes and the quality of meals are concomitant to the context in which they are served. For example, in some luxurious restaurants whose chefs are graduates from hotel / catering schools, the price of potato-based meals is high, up to 15,000 FCFA. Our findings are in line with those from studies developed by other workers with internal reference prices, price-quality inferences, and price fixing (Kotler et al., 2009; Zollinger, 2004).

Lastly, promotion is essentially provided by speaking or relational marketing based on the quality of food and the hospitality manifested to customers. This is an informal promotion. Those who advertise with promotional offers are mainly sophisticated restaurants located in hotels rated at least 3 stars or targeting a crusted clientele. The type of promotion used contributes to enhance consumption of transformed potato-based products. This is in line with the results of other researchers. Indeed, consumers are sensitive to sales promotion based on the promotional technique used. And the more the promotional technique is difficult to understand, the less consumers react to sales promotion (Fangué et al., 2014; De Pechpeyrou et al., 2006). The last part of the study consisted in better understanding the out-of-home consumption of potatoes in the major urban areas of the city of Yaounde-Cameroon. The development of urban food supply and distribution systems is an absolute necessity in West African countries to cope with the expansion of urban demand and urbanization (FAO, 1999). The consumption of prepared food outside the household is frequent in all societies in general, and in Africa in particular, a concept that is generally justified by a lack of time to cook, sometimes the means and low incomes. Consumers in urban and peri-urban areas are dependent on locally prepared food that they can buy on the street, access to products is possible everywhere, the ethnic composition of the population is changing and, in particular, brings this kind of cultural mixing to the food sector. Living conditions are generally unfavorable in sub-Saharan African countries compared to other economically less developed countries. The consumption of agricultural products, particularly potatoes in Cameroon, is not only a matter of cultivation or food habits but also of taste and ease of digestion. As the urban population of Yaounde increases, the agricultural sector has to make a greater effort to satisfy urban areas, which are par excellence the distribution areas for agricultural products such as potatoes. Potatoes for some families are not always as accessible because of their high cost

at certain times of the year, either in relation to the number of people in the household who should be fed. These family constraints generally push some people to consume it more in restaurants, but also, the preparation is not always easy for some so-called large families and for singles.

The cooking methods are not as accessible for everyone; especially the potato crush for some customers is not an easy meal to cook, so there are restaurants. During these two decades, women have embraced the world of work, which no longer allows them to cook all the time for their families or to normally consume homemade meals, but rather takeaway meals, which allows them to better manage their time, their income-generating activities and their household. The woman, head of the family, head of the company, and many other positions she holds no longer give her enough free time. It is becoming increasingly unavailable in the preparation of homemade meals.

On the other hand, customers are in a world where it is the race against time that counts, food remains a little neglected in urban areas, because of the activities or social constraints that prevent them from better controlling their food. in other words, it is a question of promoting the marketing of takeaway meals to satisfy a large number of households; in particular, complete meals that could not only lead people to eat better, but also to get closer to their food culture, strengthen and enrich their diet, and make it easier for households to better organize their daily lives. Restaurants for some remain a place of meeting and entertainment, relaxation and discovery, so that the consumption of food in the streets is becoming an increasingly widespread phenomenon in Cameroonian cities, it is without complex that consumers frequent them. Potato in Cameroonian cities is generally consumed in small roadside restaurants (tourney dos) most often in the form of chips. The itinerant sell it for the most part in the form of crushed or stewed, so the consumer finds himself in front of a panoply of dishes made from the potato. Given the ethnic groups represented around potato consumption in Cameroon, it appears that it is not only the production areas that consume it, but the whole of Cameroon, which suggests that it is necessary to promote the marketing of apples in different forms. To get back to the basics of everything that is agriculture, to promote processing, then one of the reasons to focus on agri-food processing is that agriculture has a very large direct impact on other sectors of society (Chauvin et al., 2012). In Yaounde, the majority of food consumption takes place in restaurants, which has made it easier for consumers to eat not only healthy, rich, but also fast and timely. Most of the time, people manage to eat once a day at home, usually people living alone, the rest in restaurants. However, a real problem still remains to be solved, *the potato quality problem.*

On the quality side, populations generally have difficulty to differentiate the varieties, especially consumers. Thus, in the streets they tend to confuse bad cooking (uncooked apples) with the variety used for this type of dish, which becomes a problem for restaurateurs. Most consumers have difficulty adapting to the types or varieties of potatoes on the menu, which tends to create a reluctance to eat. Consumer concerns generally relate to food safety and nutritional quality in sub-Saharan African countries, which can shift actors in the food chain from local markets, with considerable socio-economic consequences (Romanik, 2005). While food security and poverty reduction are highly desirable, this may be the case for some

African countries, and what can be achieved through investment policy away from the agricultural sector (Reardon, 2014). Also, the involvement of food hygiene enforcement can be enormous for open and street markets that have so far been the main food distributors in Sub-Saharan Africa (USAID. 2005). The popularization and sensitization on the different cooking methods, on the varieties adapted to this type of dish should also be a priority for research and would be important for restaurateurs, which would lead a large population to become even more interested in potatoes. Consumers in this study showed that the top two substitutional foods were plantain french fries (46%) followed by rice (12.1%). Thus, the vast majority of consumers rely on taste to evaluate the quality of the potato offered to them.

It was also found that the prices of the potato dishes offered depended on certain criteria such as: the shapes or types of dishes; the location as well as the services offered. The prices are such that simple apple chips between 100f and 700f in the roadside restaurants/street vendors while in other restaurants and supermarkets they vary between 1000f and 3500f. As for French fries, they are used as a side dish for some (i.e. meat, fish or chicken). Then the price of sautéed potatoes varies between 500f and 1000f as well as the mashed potatoes which varies between 500f and 700f. Finally, in urban areas or neighbourhoods, the prices of potato dishes are high. This is the case of the Bastos subdivision in the heart of the city where the prices of dishes vary between 2000f and 3500f because of some well-equipped restaurants with car parks; the staff is presentable; the quality of the service offered and well-established places. On the other hand, restaurants in the suburbs are less expensive such as Mokolo, Gare voyageur, Briqueterie where you can find restaurants and roadside restaurants that offer dishes at affordable prices. Generally it is the same quantity as in the chic subdivisions but with accessible prices that vary between 100F and 700f: because of its location, sometimes just a few chairs or benches, exposed in the open air to the eyes of all passers-by; the quality of the service offered; hygiene and its type of customers. It should be noted that most of the customers who come to restaurants the most are young people who are on average under 35 years old.

With regard to quality, this is generally not a problem for some customers, as long as they are satisfied with the product they are looking for; no matter where the marketing environment is located. The consumption of potatoes, the type of dish, the type of restaurant in Yaounde also depends on social classes, because if some consumers do not take into account the price or the price of the potato dish, it is because they are just trying to satisfy their appetite. Sometimes influenced by proximity to workplaces, but some consumers prefer to travel long distances to places they are used to frequent. Familiarity between the customer and the merchant, or because of the advertising that another consumer does to other colleagues and friends. Food consumption is affected by several factors other than income. First of all, access to food is not always easy in large cities, which influences what the population consumes (Swinburn et al., 2014; Herforth and Ahmed, 2015). Also, the city of Yaounde is a concentration of people, values, cultures and potentialities that lead to food diversity. The season also influences the price of the potato dish; then the quantity or price becomes very unaffordable to everyone. For some customers, the price of the dish is not an obstacle; they prefer to play on quantity at an affordable price, which is generally found with consumers of potato chips.

Urban dwellers consume less staple grains, more meat and dairy products, more processed food products, and a large proportion of food outside the household (Kearney, 2010; Thow et al., 2011). As a result, restaurants are multiplying thanks to the activities that are found there, at the request of customers in certain neighborhoods, or out of a need to earn a little money to support the family. Non-household consumption in large urban areas is generally influenced by the price of potato dishes, the form in which it is offered and the location of the place of sale. The dishes offered are generally common to other ethnic groups. The form of consumption is often different, such as potato pie, which is unanimously accepted on the consumption side. This dish, which was once consumed only by the populations of a few regions of Cameroon, is now almost Cameroonian-style, meaning that all ethnic groups eat it in restaurants.

This aspect is important because consumers are generally attached to their usual type of preparation. The differentiation of the final dishes consumed is also due to the diversity of the side sauces. In total, throughout the Region, a very wide variety of ingredients is used, revealing a great culinary richness per day (Bricas et al., 1991). While some of them are common to all areas, there are significant differences between them, particularly for potato pie. In Yaounde, the areas most frequented by potato consumers are the corners such as African-style roadside restaurants and restaurants, since the dishes on offer are generally better known. These roadside restaurants are usually not far from government departments, in front of carpentry shops, bars, markets, neighbourhoods, and other street vendors just walk around with the potato pot on their heads.

The marketing of food on the streets has become a better way for some not only to enhance the value of the product, but also to develop the distribution chain (marketing). As a result, standard economic tools exist to describe the relationship between income and consumption; thus, the income elasticity of demand shows how much people consume certain foods if their income increases (Herforth et al., 2015). The improvement of people's incomes and living conditions partly determine their nutritional situation. Customers who have shops or kiosks are usually served on site by itinerant merchants, when they are unable to travel at break time or when the meal on the menu is interesting. Supply chains serving domestic (mainly urban) markets have been increased and have become fundamental to national food security in sub-Saharan Africa (Reardon et al., 2014).

According to Kaufman (2005), people who live alone make few "decent meals" (rarely "good food"). They generally go to restaurants in the same way as people who live with a spouse (and possibly children). But these same people can just as easily eat "bad" if they are alone at home, especially at lunchtime during the week. To say that consumption outside the household sometimes makes up for food shortages and reinforces the diet of individuals through the variation of dishes that some people cannot afford in their homes. There is a kind of change in urban food consumption, often explained by the supposed followers, consumption by imitation of urban households towards other ethnic groups in Cameroon; willingness to imitate and adopt the consumption patterns of other populations who have come either from potato production areas or from abroad. As a result, demand for potatoes is growing in urban areas such as Yaounde where consumption is just growing and

consumption patterns differ from one consumer to another. Thus, population growth and per capita income growth are leading to an increasing demand for food and a shift from a starch-rich diet to a diet richer in sugar and fat (Van Berkum et al., 2017).

Conclusion

The first objective was to assess the suitability of potato to various processing techniques. The tuber quality parameters for processing, represented by the external aspects (tuber size, shape and eye-depth) and the internal aspects (Dry matter, Moisture content, soluble solids, pH, titratable acidity, flesh colour and browning) are influenced by tuber variety. The tubers of Cipira, Mumbi, Banso and Belo varieties are suitable for frying, mashing and roasting. Considering frying, Cipira and Mumbi with respect to size are ideal for fries while Banso and Belo are ideal for crisps. On the other hand, Dosa and Jacob are better suited for mashing and roasting while tubers of Mondial are suitable for boiling and more appropriate to be consumed in the form of salads. The overall acceptability of potato fries and boiled potatoes by a constituted panel indicated that Cipira, Banso and Mumbi varieties were most appreciated for both products. Each of these varieties is therefore, of importance as its cultivation can target a particular processing technique.

The main objective of the second part of this study was to examine outdoor potato consumption using the marketing approach. At the end of this study, the aim was to analyze the 4 P of potato consumption outside the household. As far as the product is concerned, fried potato is the most requested by customers as first choice, followed by pounded potato and at lastly, stew or roasted potatoes. Improved product quality is customer loyalty guaranteed. However, transformers have little knowledge of the quality of the potato when supplying. The place as for it depends on popular and crowded areas. There are places that already have a reputation. This means when a customer needs a specific dish, he knows where to go to satisfy his needs. From these places are added specific types of restaurant establishments. This is why in town. we mostly find hotels (3 to 5 stars), sophisticated restaurants and snack bar. In peripheral areas, there are road side restaurants, street vendors and hotels (1 to 2 stars). Few transformers make formal advertising campaigns. Advertising is mainly based on speaking. Flyers distribution is sometimes noticed and very rarely advertising via television and radio. Transformers rely on tasting campaigns (at the opening of the establishment most often) to raise awareness of their product offering. The selling prices of products are homogeneous by categories and are likely to equal at least the cost of potato products. Catering is a hybrid classified service that is constituted of food consumption and a service-delivery component. To capture and retain their customers, transformers will make a differentiated offer by combining the action levers of the 4 P mix-marketing. Thus, a good refereeing of the levers promotion, place, product and price leads to an increase in the turnover of transformers. Furthermore, transformers with knowledge of the 4P mix-marketing and who are constantly seeking to improve, increase their turnovers.

Moreover, almost half of restaurants found that the activity is profitable and that the potato has a considerable weight in their turnover, although a majority of restaurant owners noted that potato was very instrumental in the sale of other food items; almost all restaurants find that potato is very important to their business. This implies a large and permanent ordering

of potatoes given that the urban population is constantly increasing and that there is a deficit in potato production. Also, almost 17% potatoes are exported to neighbouring countries. It is therefore, an important opportunity to create jobs in the entire potato value chain. Population growth leads to an increase in demand for potato-based products and thus more jobs with more workforces and even the creation of new catering services in order to better meet demand. This also entails more workers in potato planting and in their logistics thereby boosting agriculture and the Cameroonian economy. Analysis of consumers' awareness, perceptions and attitudes towards Irish potato procurement and consumption showed some outstanding trends. Urban Cameroon like most African cities are undergoing a "nutrition transition" in which people tend to consume foods that originate from other places. Cameroon's urban areas, especially Yaounde, the capital city are rapidly growing and there is need to stimulate the intake of new foods to reduce increasing vulnerability to food shortages and consequently hunger. With this new push on production, potato (*Solanum tuberusum*) can play an important role in the national food and nutritional security, poverty alleviation, income generation and can provide employment to urban dwellers. However, culinary procedures related to potato preparation are limited and some people simply stick to their traditional taste and preferences. A number of research studies have already been conducted regarding household issues related to Irish potato consumption. Although potato is consumed by households in producing areas in various forms, for houses from non-producing areas, potato dishes are unusual in their dietary patterns. The aim of this study was to reduce food insecurity and hunger, especially in urban areas by increasing the intake of Irish potato in all its forms in urban areas of Cameroon. Findings could be exploited to sensitize and encourage people to consume more Irish potato in order to absorb the increasing production resulting from research and development activities. From the cross-sectional sample drawn from urban households living in Yaounde, Cameroon but originating from Irish potato producing and non-producing areas in Cameroon, results show that the respondents had traditional knowledge and skills that they used in distinguishing preferred raw potato tubers. With regards to Irish potato acquisition mechanisms, a majority of households that had an Irish potato farm were people originating from producing zones. Those from producing areas had a sense on how to distinguish better varieties of Irish potato using characteristics like colour, flesh texture or simply through special relationships with a potato seller. Of the meals we observed, potato traditional meals in the form of pounded potato, and porridge were mostly prepared by households from producing areas, confirming that the predisposition of tradition food systems and preferences stimulated people to consume specific foods in specific ways. It is also important to notice that a village meeting could be an important channel through which to share Irish potato consumption information.

The fourth specific objective of this project was to determine the varietal characteristics, conservation and transformation processes, commercialization and consumption of Irish potato in the Adamawa region of Cameroun. All forecast activities were carried out with the exception of the results for sensory analysis. This was due to the fact that the machine containing the results had a breakdown. These analyses will be started all over. According to the results obtained during the survey, the sampled cultivars were Doza, Bafoussam, Cipira, Panamera and Cardinal. The majority of producers (77.77%) store their produce so as to later

consume them or sell them. The constraints of production are numerous with the principal ones being the insufficient storage space (57.14) and /or the absence of storage material (21.43%), theft (14.28%) as well as rot and insect attack. As concerns transformers, they are mostly found in the category of youths (66.66%). This activity is principally carried out by women (61.54%) whose level of education is relatively high (secondary: 45.45% and university: 40.91%). They mainly evolve alone. Only 11.11% of these transformers belong to transformers' associations. Consumers fall under almost all social classes. The factors that influence the purchase or introduction of potatoes in their menus are the market price (69.23%), the revenue (53.84%), the availability on the market (50%) and the distance to the point of sale (26.92%). The choice of varieties depends on the taste, colour, nutritive value, size, purchase price, resistance to rot, starchy character and the availability. Potato commercialization is an activity in which women represent the majority (60.42%). These sellers have a relatively low level of education with 31.82% not being educated and 36.36% having primary education. Only 11.12% are members of sellers' associations. The results of the physico-chemical analysis show that the Doza variety adapts to cooking with water, vapour, as well as to frying. Whereas Cipira and Bafoussam adapt to cooking with water and vapour, while Panamera and Cardinal adapt to frying. The test carried out for the sensory analysis showed that chips from Cipira were preferred to those from Dosa.

The last part of the study consisted in better understanding the out-of-home consumption of potatoes in the major urban areas of the city of Yaounde-Cameroon, the potato products available on markets and commercial spaces, the dishes most consumed by out-of-home consumers, analysing the potential of these products, highlighting the qualities and characteristics sought for by out-of-home consumers of processed potato products, and finally finding the potential to popularize the marketing of new potato dishes. Initially, a range of potato by-products were identified in two subdivision I and II of Yaoundé whose potato consumption was more representative, such as stewed potatoes, French fries, crushed potatoes, etc., all made from potatoes. It must be said that the clientele of this product was a mix of people who came from potato production areas, but also from non-production areas, and had shared eating habits thanks to this exchange. Trade and investment policy have legitimate roles in modelling urbanization and consumption, and noting that political space will be critical for the "virtuous circles" of urbanization and rural transformation (Vorley, 2016),the population of the political capital that is practically young, potato consumption is not easily accessible in their households because of differing eating habits, but also because Yaounde is not a production area. This is in addition to the price of potatoes, which is not always stable, but also to the multiplicity of dishes on offer. For women, the points of sale of ready-to-eat meals solve the problem of availability in households, time (potato preparation, which takes a lot of time for cleaning), allow women to better manage their income-generating activities, why not enjoy themselves in restaurants when the means lend themselves to it? Young people consume more potatoes most of the time outside the home, i.e. in restaurants and other places with friends, during meetings, outings, chilling, and this usually in the form of French fries. Out-of-home consumption, of course, also promotes job creation, which is generally a better way to avoid unemployment and idleness among young traders in the informal sector. In urban areas, a multiplicity of dishes are offered since the

clientele is also large and diversified, the population is booming; incomes vary from one social stratum to another; all socio-professional classes find themselves in this wake of consumption outside the household, exchanging cultural values on all its forms. So in order to better promote the potato and to help families who do not have enough time to cook the potato in the household, it would be possible to popularize the marketing of these ready-to-eat dishes, enhance the value of this starchy food, which contains enough dry matter important for human consumption, provide new potato processing techniques and improve nutritional quality. All this could further boost the agricultural sector, which tends to feed a large number of people in Cameroon. The development of activities upstream and downstream of agriculture has resulted in new concerns related to the movement of food products from production to consumption (Padilla et al., 2001). Several factors can therefore explain out-of-home consumption: increase in working time in urban areas, increase in income, increase in leisure activities, perception of meal preparation as a chore, increase in the number of women on the labour market.

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