**Disease constraints limiting huckleberry, potato, and tomato in the Western Region of Cameroon**

**Abstract**

The West Region of Cameroon produces many Solanaceous crops, and huckleberry etc. However, significant losses of these crops occur during production and after harvest, thus impacting both their quantity and quality. During pre-harvest stages, plant diseases, pest infestations, and unfavorable weather conditions potentially reduce the crop yield, whereas in post-harvest stages, losses occur due to improper handling, storage, transportation, and processing, among others. The present study seeks to investigate the prevalence of certain plant diseases as the main constraints of the productivity of three crops (potato, tomato, and huckleberry, etc.) in the Western Region of Cameroon. This ethnobotanical survey was carried out from August 2019 to June 2020 among selected households from three divisions, encompassing four districts each. Cultural techniques and problems encountered by farmers were gathered using a questionnaire and further analyzed. Moreover, several diseased plant samples were collected and examined. Irrespective of the sex, an important number of participants were engaged in potato and tomato farming with experience ranging from two to over thirty years. Farming of huckleberries was dominated by women. These crops were found to be cultivated during dry (August to December) and rainy (March to June) seasons for market purposes. Noteworthy, most tomato growers were organized into Collective Interest Groups. Among the diseases threatening the crops, late blight was the most significant, affecting 30 to 50 percent of crops depending on the locality. The methods used by producers were mostly classified as moderately effective, which did not lead to quality preservation of the products. In addition, crop production was quantitatively affected by plant diseases, such as the late blight. Among the three crops studied, tomato was the most affected by the plant disease, followed by potato, and then huckleberry. Although significant losses are reported during farming of tomato, potato, and huckleberry, the main income of households living in the studied area comes from the cultivation of these Solanaceous crops. The common farming practices across these farms, such as crop rotation, crop association, and both inorganic and organic fertilization, are beneficial for soil health and crop production. However, the excessive use of synthetic fertilizers and pesticides, along with the lack of control over agricultural inputs, pose challenges to sustainable farming practices.

**Keywords**: Ethnobotanical survey, Solanaceous crops, Pre-harvest losses, , Disease constraints.

**INTRODUCTION**

The primary tuberous species within the Solanaceae family is potato, which is scientifically known as *Solanum tuberosum.* Other members of the Solanaceae family, while not primarily known for their tubers, include tomatoes and huckleberries. Huckleberry is a berry, while potato and tomato are both vegetables. These three food items, which are well known for their nutritional value, are the most cultivated Solanaceae plants in the Western Region of Cameroon. Tubers are a vital source of calories and revenue, making them a significant vegetable cash crop that is farmed all over the world. More specifically, tubers provide food and a living for a large number of people throughout Africa.

Millions of people, especially in underdeveloped nations, rely on potatoes as a food resource because they contain high carbs, protein, minerals, lipids, crude fiber, and vitamins (Tima Manju, et al., 2024). In addition to being used as a raw material for industrial goods, potatoes are used as food after boiling, roasting, pounding, and frying. Potatoes are also processed to manufacture animal feed (King and Slavin, 2013; Izmirlioglu and Demirci, 2015; Jagatee et al., 2015). With an estimated global output of 376.1 million tons in 2021, potato is the fourth most significant crop in the world right after rice, wheat, and maize (Jennings et al., 2020; Johnson and Auat Cheein, 2023). Small farmers in Cameroon cultivate potatoes in highland regions (Institute of Agricultural Research for Development). According to Tima Manju, et al. (2024), potatoes are mainly grown in six different regions of Cameroon, including North-West, South-West, West, Adamawa, Littoral, and Far-North. However, the agricultural production of this crop is hampered by pests and plant diseases, leading to decreased yields and economic losses. The most damaging disease includes the late blight, which is caused by a pathogenic microbe termed as *Phytophthora infestans* (Chowdappa et al., 2015). In fact, the late blight disease is responsible for over 50–70% crop losses (Tima Manju, et al., 2024). The disease mostly spreads through water-soaked lesions with asymmetrical boundaries to harm leaves, stems, petioles and tubers. These lesions commence tiny, but grow quickly in humid environments to yield significant crop losses (Sundaresha et al., 2015).

On the other hand, vegetables, which are rich in minerals and organic compounds (primary and secondary metabolites) are an important source of nutrients for humans (Tarla et al., 2015). Essential elements included in vegetables are vitamin A, C, B2, B6 and B9, calcium, phosphorus, and zinc. Noteworthy, the affordability and variety of fruits and vegetables make them superior to dietary supplements. While facing several challenges, potatoes’ production has shown a positive trend in Cameroon, thus increasing from approximately 200,000 tons in 2011 to 400,000 tons in 2020. However, this production (average of 14t/ha) is underestimated when compared with the yield of production in other countries, such as the Netherlands (430 t/ha) or Belgium (425 t/ha) (FAO, 2015). This might be due to the crop's vulnerability to insects like spider mite (Tetranychusurticae), melon fruit fly (Daucuscucurbitae), and whitefly (Bemisia tabaci), as well as diseases, such as the late blight and early blight (Tarla et al., 2015). While early blight results in yield losses of 30–60%, late blight can cause yield losses of up to 100% (Tarla et al., 2015).

Because of its nutritional value, the flavor and texture of tomato fruit improves the diet's palatability (Tarla et al., 2015). Moreover, tomatoes contain lycopene, a powerful antioxidant, which is linked to reduced cardiovascular risk (Przybylska and Tokarczyk, 2022). Another meta-analysis reviewed 25 studies and reported that high lycopene consumption and lycopene serum concentrations reduced the overall mortality by 37%, cardiovascular disease by 14%, and stroke by 23% (Collins et al., 2022). While the production of tomatoes in Cameroon is substantial (over 1,068,495 tons produced in 2018), it faces challenges, such as the vulnerability to diseases, post-harvest losses, etc.

Another vegetable, which is extensively consumed in Africa, is the huckleberry (*Solanum scabrum* Mill.), which is an edible plant in the nightshade family, often cultivated for its leaves and berries (Manoko et al., 2008). The leaves are rich in nutrients, especially proteins, iron, ascorbic acid, and riboflavin (Jiménez-Aguilar et Grusak 2015; Neugart et al., 2017). During the last years, a rising trend in the use of huckleberry by local populations has proven its proclaimed health benefits. Nutrients, such as proteins, iron, ascorbic acid, and riboflavin are found in the leaves of huckleberry (Jiménez-Aguilar and Grusak, 2015; Neugart et al., 2017). Plant diseases significantly threaten agricultural production and food security by causing substantial crop losses, reducing food availability, and impacting human health. Emerging plant diseases, in particular, may have devastating economic and social consequences, especially in low-resource settings, including African countries like Cameroon. These diseases can lead to malnutrition and, or in severe cases to famine (Gai and Wang, 2024).

Based on the foregoing, the present study seeks to identify and discuss farming systems in households producing three Solanaceous crops (potato, tomato, and huckleberry) in the Western highlands of Cameroon.

Materials and methods

***The study area***

To unravel the farming systems in households producing the three selected crops, fifteen villages located in three departments (Noun, Bamboutos and Menoua) of the Western region of Cameroon were chosen as the area of study. These villages were selected by the national extension service officers (Ministry of Agriculture, Cameroon) according to the Cameroon Agricultural database and the cultural habits of people living in selected departments. Prior to the ethnobotanical survey, the main markets of selected departments were visited to collect near huckleberry, potato and tomato sellers, and more information about potential villages to be covered during the study. Thus, a total of forty-five villages located in wetlands of the West Region of Cameroon, were covered during this ethnobotanical study. The West Region of Cameroon, which is divided into 8 departments and 40 districts, has an area of 13893 km2, a population estimated to 1952 530 inhabitants with a density of 2,5 million inhabitants per km. As already discussed, from the eight departments, three were selected according to previous records and advice from agents of the Ministry of Agriculture operating in the Region.

***Ethnobotanical investigation***

Data were collected during expeditions from appropriate locations using Participatory Research Appraisal tools and methods, such as direct observation, group discussions, individual interviews and field visits through a well-established questionnaire. To facilitate data collection, local women’s organizations were directly involved in the study at the site of collection (Figure 1). Moreover, certain characteristics of the surveyed areas (agro-ecological zone, name of location, name of sub-location, etc.) were also recorded.

***Data collection***

Data collection was performed among farmers, which were randomly selected from a list of farmers provided by the agricultural office of each district or sub-counties. The snowball method was used to interview the participants with a structured questionnaire. The meeting with huckleberry, potato and tomato farmers was facilitated by the agricultural extension agents. Two sub-counties were covered in each district, with more than 30 farmers interviewed and at least one key informant group discussion. Farmers were interviewed in French. After that, infected and non-infected plant samples were collected for further experiments.

***Survey***

The prevalence and severity of late blight were evaluated in huckleberry, potato and tomato, which are the prevalent crops growing in Bamboutos, Menoua and Noun divisions. Fields were visited twice at the vegetative stage of the studied plants. The percentage of plant area affected by the disease was recorded on three randomly selected sites of each location.

***Assessment of disease incidence***

The disease incidence was evaluated according to a previously described protocol by Meya et al*.* (2015). To select the three fields required for disease assessment of each plant and recording, a disc was thrown randomly at each location. Upon landing of the disc on each site, ten plants were selected around the landing area whereby the total number of infected (with late blight) and non-infected leaves were recorded on four branches and three sections, including lower, middle and upper portions of each plant. Disease incidence was calculated using the following formula:

Disease incidence (%) = (n/N) x100.

Where n is the number of leaves with late blight symptoms and N is the total number of leaves recorded. An average percentage for the ten plants illustrated the disease incidence of respective sites, whereas an average percentage of three sites revealed the disease incidence of the concerned locality.

***Severity***

The severity of the disease on the studied plant leaves was measured according to a graded scale (0-5), as previously described by Sokhi et al. (1993).

Accordingly: 0 = No disease; 1 = Up to 20% leaf area affected; 2 = 21-40 % leaf area affected; 3 = 41-60% leaf area affected; 4 = 61-80% leaf area affected and 5 = More than 80 % leaf area affected.

***Data Processing and Analysis***

Results obtained from the study of the three crops (tomato, potato and huckleberry) are presented in tabular form. To analyze farmers’ demographics, the socio-economic characteristics of these smallholders were subjected to Principal Component Analysis, followed by a hierarchical ascendant classification (HAC) to cluster surveyed households into groups based on their similarityThen, analyses were carried out according to the household classes obtained from HAC. These consisted of descriptive statistics (mean followed by standard deviation) and calculations of the frequencies.

**RESULTS**

**1. Demographic information of the respondents**

**1.1. Tomato farmers**

Table 1 summarizes the demographic information of tomato farmers. Tomato farming demographics vary, but generally show a higher representation of males. For example, only two districts (Penka Michel and Foto) out of eight showed 20% and 10% of females, respectively, whereas in the remaining six districts, 100% of tomato farmers were males. Most of the respondents In view of longevity in tomato farming, producers from Galim had longevity of more than 10 years and were found to be the most experienced farmers followed by producers from Foto (Menoua department), Foumbot and Bamendzi (Noun division), then Penka Michel, Dschang and Batcham (Table 1). Almost all the respondents were farming tomatoes for trade.

**1.2. Huckleberry producers**

Table 2 shows the demographic distribution among huckleberry farmers. In general, huckleberry demoraphics vary, but show a higher representation of females compared to their male counterparts. In the Dschang district, 20% of male were found cultivating huckleberry, whereas in the remaining districts (7 districts) only women were farming huckleberry (100%). In the Batcham district, the average age of huckleberry farmers ranged from 33 to 44 years, whereas in Foto (Menoua department), farmers were aged more than 44 years. In Foumbot (Noun department), huckleberry producers were aged >30 years, whereas in Dshang (Menoua), the respondents were aged 20 years and above. Regarding the longevity in huckleberry farming, the producers showed at least one year of experience in this agricultural activity. A handful of respondents in Bafou and Foumbot were farming huckleberry for consumption (subsistence farming) (Table 2).

**1.3. Potato producers’ respondents**

The demographic information of potato farmers is summarized in Table 3. Producers of potato were dominated by male (10% female vs 90% male) in Bafou and Penka Michel districts, whereas only men (100%) were found farming potatoes in the Dschang district. Most of the respondents were within the age group « 30-45 ». In view of longevity in potato farming, producers from Bafou had a longevity of more than 4 years and were found to be the most experienced potato farmers followed by producers from Dschang and Penka Michel (Menoua department) (Table 3). Almost all the respondents were farming tomatoes both for trade and home consumption.

**Table 1**: Demographic information of among tomato farmers

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Departments** | **Districts** | **Sex** | | **Age group** | **Farming experience (longevity)** | **Reason for plant**  **cultivation** | | **Season** | **Cooperative association** |
|  |  | **MALE** | **FEMALE** |  |  |  | |  |  |
| **BAMBOUTOS** | BATCHAM | 100% |  | 30-45 years | >2 years | | Trade | Dry and wet seasons | NS |
|  | GALIM | 100% |  | 33-44 years | >10 years | Trade | | Dry and wet seasons | NS |
| **MENOUA** | DSCHANG | 100% |  | >30 years | >2 years | Trade | | Dry and wet seasons | No |
| PENKA MICHEL | 80% | 20% | ≥30 years | >4 years | | Trade | Dry and wet seasons | No |
| FOTO | 90% | 10% | >30 years | >5 years | Trade | | Dry and wet seasons | No |
| **NOUN** | FOUMBOT | 100% |  | >30 years | > 5 years | Trade | | Dry and wet seasons | No |
| BAMENDZI | 100% |  | >30 years | > 5 years | | Trade | NS | No |

NS : Not specified.

**Table 2:** Demographic information of huckleberry producers’ respondents

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Departments** | **Districts** | **SEX** | | **Age group** | **Farming experience (longevity)** | **Reason for plant**  **cultivation** | **Season** | **Cooperative association** |
|  |  | **Male** | **Female** |  |  |  |  |  |
| **BAMBOUTOS** | BATCHAM |  | 100% | 33-44 years | > 4 years | Trade | All seasons | No |
| GALIM | NS | NS | NS | NS | NS | NS | NS |
| **MENOUA** | DSCHANG | 20% | 80% | > 20 years | > 1 year | Trade | All seasons | No |
| BAFOU |  | 100% | > 44 years | 4 years | Trade, Subsidence | All seasons | No |
| PENKA MICHEL | NS | NS | NS | NS | NS | NS | NS |
| FOTO | NS | NS | NS | NS | NS | NS | NS |
| **NOUN** | FOUMBOT | NS | 100% | > 30 years | >3 years | Trade, Subsidence | All seasons | No |
| BAMENDZI | NS | NS | NS | NS | NS | NS | NS |

NS : Not specified.

**Table 3**:Demographic information of irish potato producers

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Department** | **Districts** | **Sex** |  | **Age group** | **Farming experience (longevity)** | **Reason for plant**  **cultivation** | **Season** | **Cooperative**  **association** |
|  |  | **Male** | **Female** |  |  |  |  |  |
| **BAMBOUTOS** | BATCHAM | NS | NS | NS | NS | NS | NS | NS |
| GALIM | NS | NS | NS | NS | NS | NS | NS |
| **MENOUA** | DSCHANG | 100% | NS | > 20 years | ≥1 year | Trade,  Subsidence | All seasons | No |
| BAFOU | 90% | 10% | 25-44 years | ≥4 years | Trade,  Subsidence | All seasons | No |
| PENKA MICHEL | 90% | 10% | >30 years | >1 year | Trade | All seasons | No |
| FOTO | NS | NS | NS | NS | NS | NS | NS |
| **NOUN** | FOUMBOT | NS | NS | NS | NS | NS | NS | NS |
| BAMENDZI | NS | NS | NS | NS | NS | NS | NS |

NS : Not specified.

**2. Frequency and severity of tomato diseases and plant management with pesticides and fertilizers in the area of study**

According to Table 4, a number of plant diseases, including late blight, plant virosis, gadfly, wilt, rust, *Alternaria* blight, and Whitefly were found to infect tomatoes in the area of study. Irrespective of the department studied, late blight disease was the most prevalent with higher percentages in Galim (Bamboutos) (35%), Dschang (Menoua) (50%), and Bamendzi (Noun) (20-30%). The mostly used fertilizer was 20-10-10, followed by 12-14-19, 19-12-19 and 13-15-20. To eliminate the pests, synthetic fongicides, such as Pencozeb, Manco star, Kalao, Jumper, chlorothalonyl, and flash one, were commonly used by tomato farmers. A handful of tomato producers from Penka Michel (Menoua), Foumbot and Bamendzi (Noun) usually use chicken manure (biofertilizer or organic fertilizer), rather than synthetic fertilizers. In Bamboutos and Menoua, Rio power and Sakata were the most cultivated varieties of tomato, whereas in the Noun department, cultures were dominated by Kiero, Long courier, Padma, Griffaton, Rio power, and hybrids (Table 4).

**3. Occurrence and severity of garden huckleberry diseases and follow-up using pesticides and fertilizers in the area of study**

Table 5 summarizes the occurrence and severity of diseases affecting huckleberry and their management using pesticides. Diseases affecting huckleberry mostly comprised late blight (frequency: 100% in Batcham, Dschang, Bafou and Penka Michel) and whitefly infections (frequency: 50% in Penka Michel). Fongicides, such as Caiman, Sicon, Agropic, bonsoin, Mon champ, Manco star and insecticides like K. optimal were used to reduce the devastating effects of the plant diseases. The most cultivated variety of huckleberry was termed as Large leaves-Foumbot. Although a number of farmers employ the synthetic fertilizer 20-10-10 to cultivate huckleberry, other producers were accustomed to the use of chicken manure for their plant production. Farming activities were carried out in all seasons.

**4. Prevalence and intensity of garden huckleberry diseases and management using pesticides and fertilizers in the studied districts**

Almost all potato farmers were found in the Menoua department where Desire and Doza are the most cultivated potato varieties. These varieties were mostly attacked by late blight (frequency : 50-100%), followed by whitefly and caterpillar infections. Fongicides, such as Balea, Pencozeb, Manezan, Agropic, Bonsoin, Gardien, as well as the insecticide K optimal. To facilitate the plant growth and increase the productivity, the fertilizer 20-10-10, was used by a number of producers, even though others were keen to use natural fertilizers, such as the chicken manure.

**Table 4:** Frequency and intensity of tomato diseases and plant management with pesticides and fertilizers

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Department** | **Districts** | **Variety of plants** | **Types of diseases in the field/Pests** | **Incidence** | **Severity** | **Frequency** | **Treatments** | **Fertlizer used** | **Season** |
| **BAMBOUTOS** | BATCHAM | RIO POWER; SAKATA | Late blight | 2% | 1 | 80% | Fongicides  (Metro star, Mancozan) | 12-14-19 | All seasons |
|  | Virosis | 4% | 4 | 80% | Insecticide | NS | NS |
|  | Alternaria blight | 5% | 1 | 25% | NS | 21-20-11 | NS |
|  | Rust | 10% | 1 | 25% | NS | NS | NS |
|  |  | Wilt | 3% | 1 | 50% |  |  |  |
| GALIM | RIO POWER; SAKATA | Late blight | 35% | 2 | 100% | Pesticides  (Kalao, Agropik) | NS | All seasons |
|  | Virosis | NS | NS | NS | NS | 20-10-10 | NS |
|  | Flies | NS | NS | NS | NS | NS | NS |
| **MENOUA** | DSCHANG | PADMA, LADY, NEYMA, SAKATA | Late blight | 50% | 1 | 50% | Fongicide (Bonsoin, Agropic, Gardien) | 12-14-19 | All seasons |
|  | Virosis | 30% | 3 | 25% | Insecticide (Kannon) | 20-10-10 | NS |
|  | Alternaria blight | 50% | 1 | 100% | NS | NS | NS |
|  | Rust | 30% | 1 | 20% | NS | NS | NS |
|  | Gadfly | 20% | 5 | 25% | NS | NS | NS |
| BAFOU | RIO POWER; SAKATA | Late blight | 20% | 1 | 100% | Fongicides (Chlorothalonyl, flash one) | 19-12-19 | NS |
|  | Whitefly | 25% |  | NS | Feromone | 13-15-20 | NS |
|  | Alternaria blight | 5% | 4 | 100% | NS | NS | NS |
|  | Virosis | 10% | 1 | 20% | NS | NS | All seasons |
| PENKA MICHEL | RIO POWER; SAKATA | Late blight | 5% | 1 | 100% | Fongicide (Flash one, jumper) | Chicken manure | NS |
|  | Alternaria blight | 20% | 1 | 50% | NS | NS | NS |
|  | Virosis | 35% | 5 | 20% | NS | NS | NS |
|  | NS |  | NS | NS | NS | NS | All seasons |
| FOTO | RIO GRANDE, PADMA,COBRA | Wilt | 5% | 5 | ˂5% | Fongicide (Bonsoin, Manezan, Gardien) | NS | NS |
| **NOUN** |  |  |  |  |  |  |  |  |  |
| FOUMBOT | RIO POWER, KIERO, LONG COURIER, PADMA, GRIFFATON | Late blight | 5% | 1 | 90% | Fongicide (Pencozeb, Manco star, Kalao, Jumper) | 20-10-10 | All seasons |
|  | Virosis | 3% | 1 | 20% | NS | Chicken manure | NS |
|  | Wilt | 20% | 1 | 80% | NS | NS | NS |
|  | Rust | 15% | 1 | 20% | NS | NS | NS |
|  | Gadfly |  |  |  | NS | NS | NS |
| BAMENDZI | Hybrid | Late blight | 20-30% | 2 | 90% | Fongicide (Pencozeb,Manco star, Kalao, Jumper) | 20-10-10 | NS |
|  | Wilt | NS | NS | NS | NS | Chicken manure | All seasons |
|  | Rust | NS | NS | NS | NS | NS | NS |
|  | Gadfly | NS | NS | NS | NS | NS | NS |

**Table 5:** Ocurrence and severity of garden huckleberry diseases, and follow-up with pesticides and fertilizers in the area of study

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Department** | **Districts** | **Variety of plant** | **Types of diseases in the field/Pests** | **Incidence** | **Severity** | **Frequency** | **Treatments** | **Fertlizer used** | **Season** |
| **BAMBOUTOS** | BATCHAM | Foumbot  (large leaf) | Late blight | 5% | 1 | 100% | Fongicides (bonsoin, Mon champ, jumper) | NS | NS |
| NS | Caterpillar | NS | NS | NS | Insecticide (Caiman, Sicon) | NS | All seasons |
| GALIM | NS | NS | NS | NS | NS | NS | NS | NS |
| **MENOUA** | DSCHANG | Foumbot  (large leaf) | Late blight | 10-15% | 1 | 100% | Fongicides (Agropic) | 20-10-10 | NS |
| NS | Whitefly | NS | NS | NS | NS | Chicken manure | All seasons |
| BAFOU | Foumbot  (large leaf) | Late blight | 5-10 % | 1 | 100% | NS | 20-10-10 | All seasons |
| NS | Wilt | NS | NS | NS | NS | Chicken manure | NS |
| PENKA MICHEL | Foumbot  (large leaf) | Late blight | 50% | 2 | 100% | Fongicides (bonsoin, Mon champ) | 20-10-10 | NS |
| NS | Whitefly | 60% | 1 | 50% | Insecticides (K. optimal) | Chicken manure | All seasons |
| **NOUN** | FOTO | NS | NS | NS | NS | NS | NS | NS | NS |
| FOUMBOT | Foumbot  (large leaf) | Late blight | 5% | 1 | 80% | Pesticides (Manco star) | Chicken manure | All seasons |
| NS | Whitefly | NS | NS | NS | NS | NS | NS |
| BAMENDZI | NS | NS | NS | NS | NS | NS | NS | NS |

NS : Not specified.

**Table 6:** Prevalence and intensity of Irish potato diseases, and pmanagement of plants with pesticides and fertilizers in the studied area.

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Department** | **Districts** | **Variety of plant** | **Types of diseases in the field/Pests** | **Incidence** | **Severity** | **Frequency** | **Treatments** | **Fertlizer used** | **Season** |
| **BAMBOUTOS** | BATCHAM | NS | NS | NS | NS | NS | NS | NS | NS |
| GALIM | NS | NS | NS | NS | NS | NS | NS | NS |
| **MENOUA** | DSCHANG | DOZA, DESIRE, SPIRA | Late blight | 10% | 1 | 50% | Fongicide (Balea) | 20-10-10 | All seasons |
| NS | Rust | NS | NS | NS | Insecticide K optimal | Chicken manure |  |
| NS | NS | NS | NS | NS | NS | 13-13-21 | NS |
| BAFOU | DESIRE, DOZA | Late blight | 80% | 2 | 100% | Fongicide (Pencozeb, Manezan, Gardien) | 20-10-10 | All seasons |
| NS | NS | NS | NS | NS | NS | Chicken manure | NS |
| PENKA MICHEL | DESIRE | Late blight | 70% | 2 | 75% | Fongicide (Agropic, Bonsoin Gardien) | 20-10-10 | NS |
| NS | Whitefly, caterpillar | NS | NS | NS | NS | Chicken manure | All seasons |
| FOTO | NS | NS | NS | NS | NS | NS | NS | NS |
| **NOUN** | FOUMBOT | NS | NS | NS | NS | NS | NS | NS | NS |
| BAMENDZI | NS | NS | NS | NS | NS | NS | NS | NS |

NS : Not specified.

**Discussion**

The Solanaceae family, which includes plants such as tomatoes, potatoes, and huckleberries, is a diverse and important family of plants, especially in terms of food and other uses. These plants are among the most valuable crops after the major cereal grains rice, wheat, and corn (Svobodová and Kuban, 2018). Plant pathogenic microbes cause substantial yield losses in several economically important crops, including tomato, potato and huckleberry (Rasul et al., 2019). Late blight, which is caused by *Phytophthora infestans* (Mont.) de Bary is an important disease in potato (*Solanum tuberosum* L.) and tomato (*Lycopersicon esculentum* Mill.). In the tropical highlands of Cameroon, this pathogen affects garden huckleberry (*Solanum scabrum* Mill.), tomatoes and potatoes (Fontem et al., 2005). Other infections that are prevalent in these crops include early blight (caused by *Alternaria solani*), tomato spotted wilt virus, whitefly and caterpillar infections, among others (Naalden et al., 2021 ; Schmey et al., 2024 ; Rebecca C., 2024). Most of these infections are usually controlled by the use of fongicides, and insecticides, etc. On the other hand, the quality control of these crops is ensured by the use of synthetic fertilizers. Noteworthy, quality control in agriculture involves various practices, including seed selection, pest and disease management, and post-harvest handling (Tudi et al., 2021).

In view of the importance and economic contribution of potato, tomato and huckleberry farming in the Western Region of Cameroon, the present study aimed to characterize the occurrence and prevalence of diseases affecting tomato, potato, and huckleberry as well as their management by using fertilizers and pesticides. To this end, an ethnobotanical survey was conducted in eight districts located in three different divisions of the Western Region of Cameroon, to identify the types of diseases that affect tomato, potato and huckleberry, their occurrence and severity, and to unravel farming practises, such as the use of fertilizers, pesticides. Moreover, the demographic information of the respondents was also recorded. Tomato and potato farming demographics vary, but generally show a higher representation of males. Perez et al. (2015) attributed the more involvement of men than women in farming a number of crops to the fact that women control less land than men, have less access to common property resources, as well as to cash to obtain goods or services (Perez et al., 2015). Doss et al. (2018) partially agree with this assertion and believe that these claims are myths that are not based on sound empirical evidence and that the concept behind the statement are not straightforward, even though there is a truth that women control fewer resources than those required to fulfill their responsibilities to ensure food and nutrition security for themselves and their families (Doss et al., 2015). In Sub-Saharan Africa and Asia, nationally representative data demonstrate that women own substantially less land, even though sex-separated data on [land ownership](https://www.sciencedirect.com/topics/social-sciences/landownership) is still very limited ([Doss et al., 2015](https://www.sciencedirect.com/science/article/pii/S2211912417300779" \l "bib22), [Kieran et al., 2015](https://www.sciencedirect.com/science/article/pii/S2211912417300779" \l "bib31)). Perhaps, this assertion from Doss et al. (2015) makes sense ever since huckleberry producers were dominated by females than their male counterparts in this study. While some studies suggest women tend to be more at risk-averse, other research indicates that gender differences in risk aversion might not be as significant as initially thought (Ddamulira et al., 2021).

In tomato and potato farming, up to 10 years of longevity was recorded, while most of the respondents were found within the age group 30-45. The majority of farmers producing huckleberry were aged above 30 years. Irrespective of the plant, the majority of producers practised cash cropping over subsidence farming. In Cameroon, smallholder farmers are the backbone of food security and contribute significantly to the country's staple crop production. Specifically, smallholder farmers play a fundamental role in sustainable food and nutrition security through the production of nutritious food (Kapari et al., 2023). However, due to the economic crisis in the developing world, and the increase in accessibility of land to smallholder farmers, many producers have ventured into cash crop production (Touch et al., 2024). This shift is a response to the need for income generation and economic survival.

Among the smallholder farmers involved in tomato production, the majority were within the age group 30-45. The relatively low youth participation compared to adults was possibly due to limited or lack of funds to invest in acquisition of inputs that are required for tomato farming. The youth’s lack of interest in agriculture is significantly influenced by perceptions of low rewards and limited access to land, thus hindering their participation and driving them towards urban employment. Many young people view agriculture as a low-status, backbreaking occupation with limited financial returns, further discouraging them from pursuing farming as a career (Ng’atigwa et al., 2020; Boye et al., 2024). Irrespective of the plant identified, common diseases threatening the cultures included late blight, followed by plant virosis, Alternaria blight, wilt, rust, and whitefly infections. Accumulated evidence has shown that plants from the same family share several botanical similarities and are likely to be attacked by the same pathogens (Schmidt et al., 2020; Lu et al., 2021). Most of the farmers use fungicides or pesticides to overcome the infection in the plant. Agropic and Bonsoin (in the Menoua division), and Mancozan, Jumper, Agropic, and Pencozeb (in Bamboutos and Noun) were found to be the most utilized fertilizers. As already reported by other authors, the use of such chemical fertilizers is a common practice in many regions of Cameroon (Sonchieu et al., 2017; Tsufac et al., 2021). To mitigate the detrimental effects of chemical fertilizers, such as reduced organic matter, harm to beneficial soil microorganisms, and altered soil’s pH, some farmers were using chicken manure as a natural biofertilizer. This practice helps improve soil health by providing a more sustainable and beneficial source of nutrients (Liu et al., 2024). On the other hand, the overuse and misuse of chemical fertilizers contribute to the development of resistance by pests. Although late blight was well recorded in every district, its severity and prevalence varied, and the disease burden was generally higher in Bamboutos and Noun than in the Menoua division. Irrespective of the division covered, farmers complain regarding the high cost of fertilizers that did not allow them to efficiently use fertilizers for crop productivity.

Overall, the present ethnobotanical study revealed that in three divisions of the Western Region of Cameroon, tomato and potato farming are dominated by males, whereas the majority of huckleberry producers were found to be females. Most of these farmers practice cash cropping rather than producing crops for their own consumption (subsidence farming). Data collected in this study revealed diverse challenges faced by farmers when cultivating tomatoes, potatoes, and huckleberries. These include post-harvest losses, pest and disease infestations, and access to markets and resources. To overcome pest and disease infestations, most of these farmers use varieties of fungicides and insecticides, which are detrimental to human health and may also contribute to the development of resistance by pests. Indeed, the overuse of fungicides and insecticides by farmers to control pests and diseases is a significant concern due to its harmful effects on human health and its potential to cause pest resistance. To increase productivity, most of the farmers use a number of chemical fertilizers, while a few of them rely on chicken manure to enrich the soil.

**CONCLUSION**

The aim of this study was to identify farming systems in households producing potato, tomato and huckleberry in the Western highlands of Cameroon. The demographic information revealed a male dominance and limited youth participation in the production of tomato, potato, and huckleberries by smallholders in West Cameroon. Commonly used tomato varieties included Sakata, Griffaton and Rio Grande, which are high yielding but costly in terms of seeds. Doza and Desire for the potato culture and Foumbot variety for huckleberry were the most predominant. The major diseases and pests reported included bacterial wilt, late blight, early blight, rust and virosis. For the management of pests, many smallholder farmers used mainly synthetic fungicides and insecticides. Therefore, smallholder farmers are suggested to use an array of management options, including biological control agents, which are crucial components of integrated pest management strategy for controlling diseases, arthropod pests and weeds. Women in Cameroon play a crucial part in satisfying the food and nutrition requirements of their families through food production, economic access to food, and nutrition security, even though they are inadequately resourced. Removing constraints and providing equitable access to resources can significantly boost female participation in tomato and potato production. By addressing barriers like access to land, finance and technology, women can become more involved in all stages of the tomato and potato value chain, leading to increased production and economic benefits. To increase women's participation in tomato production, governments at all levels should implement policies that address both physical and human capital constraints. This includes providing access to land, credit, and resources, as well as investing in education, training, and support for women in agriculture. Addressing these constraints can empower women, improve yields, and increase their income. Engaging young people in tomato production is crucial because they represent both a valuable labor pool and a potential for entrepreneurial growth, contributing to job creation and economic development.

Innovations in developing effective integrated low-cost pest and disease management options to reduce the cost of the production should be supported, especially by the government and stakeholders.

This research highlights the various constraints faced by producers of tomatoes, potatoes, and huckleberries in the Western Region of Cameroon. These constraints include access to financial resources, yield improvement and effective pest and disease management. Further studies could focus on the use of these data to develop new strategies to address these challenges and improve the productivity and profitability of Solanaceous crops.

**Data Availability Statement :** Data is available from the corresponding author upon reasonable request.

**REFERENCES**

Boye, M., Ghafoor, A., Wudil, A. H., Usman, M., Prus, P., Fehér, A., Sass, R. (2024) Youth Engagement in Agribusiness : Perception, Constraints, and Skill Training Interventions in Africa: A Systematic Review. Sustainability., 16(3), 1096. <https://doi.org/10.3390/su16031096>

Chowdappa, P., Nirmal Kumar, B. J., Madhura, S., Mohan Kumar, S. P., Myers, K. L., Fry, W.E., Cooke, D. E. L. (2015).Severe outbreaks of late blight on potato and tomato in South India caused by recent changes in the *Phytophthora infestans* population. Plant Pathol., 64(1), 191-199.

Collins, E. J., Bowyer, C., Tsouza, A., Chopra, M. (2022). Tomatoes : An extensive review of the associated health impacts of tomatoes and factors that can affect their cultivation. Biology (Basel)., 11(2), 239. doi: 10.3390/biology11020239.

Ddamulira, G., Isaac, O., Kiryowa, M., Akullo, R., Ajero, M., Logoose, M., Otim, A., Masika, F., Mundingotto, J., Matovu, M., Ramathani, I. (2021). Practices and constraints of tomato production amond smallholder darmers in Uganda. Afr. J. Food Agric. Nutr. Dev. 21(2), 17560-17580

Doss, C., Kovarik, C., Peterman, A., Quisumbing, A., van den Bold, M., 2015. Gender inequalities in ownership and control of land in Africa: myth and reality.  Agric. Econ. 46, 403–434.

Doss, C., Dick, R. M., Quisumbing, A., Theis, S., 2018. Women in agriculture : Four myths. Glob. Food Sec., 16, 69-74.

FAO (Food and Agriculture Organization of the United Nations) (2015). Summarized data from 1970–1990s estimates of Asia and Latin America farm households. <https://www.fao.org/4/y1860e/y1860e09.htm>

Fontem, D. A., Olanya, O. M., Tsopmbeng, G. R., Owona, M. A. P. (2005b). Pathogenicity and metalaxyl sensitivity of *Phytophthora infestans* isolates obtained from garden huckleberry, potato and tomato in Cameroon. Crop Prot. 24 (5), 449-456.

Gai, Y., Wang, H. (2024) Plant disease: A growing threat to global food security. Agronomy. 14(8) 1615. <https://doi.org/10.3390/agronomy14081615>

Izmirlioglu, G., Demirci, A. (2015). Enhanced bio-ethanol production from industrial potato waste by statistical medium optimization. Int. J. Mol. Sci. 16, 24490-24505.

Jagatee, S., Behera, S., Dash, P. K., Sahoo, S., Mohanty, R. C. (2015). Bioprospecting starchy feedstock’s for bioethanol production: A future perspective. J. Microbiol. Res. Rev. 3, 24-42.

Jennings, S. A., Koehler, A.-K., Nicklin, K. J., Deva, C., Sait, S. M., Challinor, A. J. (2020) Global potato yields increase under climate change with adaptation and CO2 fertilisation. Front. Sustain. Food Syst. 4, 519324. doi: 10.3389/fsufs.2020.519324

Jiménez-Aguilar, D. M., Grusak, M. A. (2015). Evaluation of minerals, phytochemical compounds and antioxidant activity of Mexican, Central American, and African green leafy vegetables. Plant Foods Hum. Nutr. 70, 357–364.

Johnson, C. M., Auat Cheein, F. (2023) Machinery for potato harvesting: a state of-the-art review. Front. Plant Sci. 14, 1156734. doi: 10.3389/fpls.2023.1156734

Kapari, M., Hlophe-Ginindza, S., Nhamo, L., Mpandeli, S. (2023). Contribution of smallholder farmers to food security and opportunities for resilient farming systems. Front. Sustain. Food Syst. 7, 1149854. doi: 10.3389/fsufs.2023.1149854

Kieran, C., Sproule, K., Doss, C., Quisumbing, A., Mi Kim, S. (2015). Examining gender inequalities in land rights indicators in Asia. Agric. Econ. 46, 119-138.

King, J. C., Slavin, J. L. (2013). White potatoes, human health, and dietary guidance. Adv Nutr. 4(3) 393S-401S.

Liu, Y., Lan, X., Hou, H., Ji, J., Liu, X., Lv, Z. (2024) Multifaceted ability of organic fertilizers to improve crop productivity and abiotic stress tolerance: Review and perspectives. Agronomy, 14(6), 1141. <https://doi.org/10.3390/agronomy14061141>

Manoko, M. L. K., van den Berg, R. G., Feron, R. M. C., van der Weerden, G. M., Mariani, C. (2008). Genetic diversity of the African hexaploid species *Solanum scabrum* Mill. and *Solanum nigrum* L. (Solanaceae). Genet. Resour. Crop. 55, 409–418.

Meya, D., Rajasingham, R., Nalintya, E., Tenforde, M., Jarvis, J.N. (2015). Preventing cryptococcosis shifting the paradigm in the era of highly active antiretroviral therapy. Curr Trop Med Rep. 2(2), 81-89.

Naalden, D., van Kleeff, P. J. M., Dangol, S., Mastop, M., Corkill, R., Hogenhout, S. A., Kant, M. R., Schuurink, R. C. (2021). Spotlight on the roles of whitefly effectors in insect-plant interactions. Front. Plant Sci. 12, 661141. doi: 10.3389/fpls.2021.661141.

Neugart, S.; Baldermann, S.; Ngwene, B.; Wesonga, J.; Schreiner, M. (2017). Indigenous leafy vegetables of Eastern Africa—A source of extraordinary secondary plant metabolites. Food Res. Int. 100, 411–422.

Ng’atigwa, A. A., Hepelwa, A., Yami, M., & Manyong, V. (2020). Assessment of factors influencing youth involvement in horticulture agribusiness in Tanzania: A case study of Njombe Region. Agriculture, 10(7), 287. <https://doi.org/10.3390/agriculture10070287>

Perez, C., Jones, E.M., Kristjanson, P., Cramer, L., Thornton, P.K., Förch, W., Barahona, C. (2015). How resilient are farming households and communities to a changing climate in Africa? A gender-based perspective. Global Environ. Change 34, 95-107.

Rasul, I., F. Zafar, M.A. Ali, H. Nadeem, M.H. Siddique, M. Shahid, Ashfaq, U. A., Azeem, F. (2019).Genetic basis for biotic stress resistance in plants from Solanaceae family:A review. Int. J. Agric. Biol. 22, 178-194.

Rebecca Creamer, 2024. Chapter 48 - Bell pepper. Viral Diseases of Field and Horticultural Crops. Pages 401-409.

Schmey, T., Tominello-Ramirez, C. S., Brune, C., Stam, R. (2024) *Alternaria* diseases on potato and tomato. Mol. Plant Pathol., 25(3) e13435. doi: 10.1111/mpp.13435.

Schmidt, R., Auge, H., Deising, H. B., Hensen, I., Mangan, S. A., Schädler, M., Stein, C., Knight, T. M. (2020) Abundance, origin, and phylogeny of plants do not predict community-level patterns of pathogen diversity and infection. Ecol. Evol., 10(12), 5506-5516. doi: 10.1002/ece3.6292.

Sokhi, S. S., Thind, T. S., Dhillon, H. S. (1993). Late Blight of potato and tomato. Punjab Agricultural University, Ludhiana. Directorate of research publication. pp. 19.

Sonchieu, J., Ngassoum, M. B., Nantia Akono, E., Laxman, P. S. (2017). Pesticide applications on some vegetables cultivated and health implications in Santa, North West-Cameroon. SSRG International Journal of Agriculture & Environmental Science, 4(2), 39-46. <https://doi.org/10.14445/23942568/IJAES-V4I2P108>

Sundaresha, S., Kumar, S., Singh, B. P., Jeevalatha, A., Rawat, S., Mahota, A. K., Sharma, T. R. (2015). Comparative genome analysis of Irish famine pathogen with Indian Phytophthora infestans isolate. In: 3rd International symposium on *Phytophthora*: Taxonomy, genomics, pathogenicity, resistance and disease management. 9th–12th September, 2015. Bengaluru, India 3(1), 24-28.

Svobodová, B., Kuban, V. (2018). Solanaceae: A family well-known and still surprising. Phytochemicals in Vegetables: A Valuable Source of Bioactive Compounds. Editor(s): Spyridon A. Petropoulos, Isabel C.F.R. Ferreira, Lilian Barros, 296-372.

Tarla, D. N., Manu, I. N., Tamedjouong, Z. T., Kamga, A., Fontem, D. A. (2015). Plight of Pesticide Applicators in Cameroon: Case of Tomato (*Lycopersicon esculentum* Mill.) Farmers in Foumbot. J. Agric. Environ. Sci. 4 (2), 87-98.

Tima Manju, E. B., Nadine Toh, B., Arrey, D. B. (2024). Evaluation of plant extracts and tissue culture cultivars in the control of potato late blight disease. J. Yeast Fungal Res. 15(2), 8-15.

Touch, V., Tan, D. K. Y., Cook, B. R., Liu, L., Cross, R., Tran, T. A., Utomo, A., Yous, S., Grunbuhel, C., Cowie, A. (2024) Smallholder farmers' challenges and opportunities: Implications for agricultural production, environment and food security. J. Environ. Manage., 370, 122536. doi: 10.1016/j.jenvman.2024.122536.

Tsufac, R. A., Nyong, P. A., Bernard, P. K. Y. (2021).A comparative analysis of agrochemical use among agroforestry and non-agroforestry practicing farmers in South west Cameroon: The examples of insecticides, fungicides and herbicides. Afr. J. Agric. Res., 17 (4), 557-570.

Tudi, M, Daniel Ruan, H, Wang, L, Lyu, J., Sadler, R., Connell, D., Chu, C., Phung, D.T. (2021) Agriculture development, pesticide application and its impact on the environment. Int. J. Environ. Res. Public Health. 18(3) 1112. doi: 10.3390/ijerph18031112.

General comments about the manuscript

The introduction of this manuscript is difficult to comprehend because it lacks a clear problem statement, research gap I suggest that the authors revise the introduction to incorporate these crucial elements, thereby completing the manuscript. The research methodology lacks research design, a detailed description of the study area, a map, sample size determination, sampling procedures, and data analysis methods.

The findings were not effectively conveyed, and the discussion sections were insufficiently developed, making comprehension challenging.

The manuscript contains grammatical mistakes, necessitating thorough editing before it can be considered for publication.

All the references have been created by hand; it is advisable to use Reference Manager for automatic generation and to update all outdated references in the manuscript with the latest ones.

Therefore, this manuscript requires a major revision before acceptance for possible publication in your journal.