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Research Article

Assessing Postharvest Diseases and Losses of Tomato in Selected Areas of Ethiopia

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ABSTRACT

The survey was conducted for two years from 2018 – 2019 cropping seasons, in five zones, east Wollega, west Shewa, south Tigray, north and south Wello. The collected data was analyzed using SPSS software (Version 26.0) and means were compared for the significant difference. Descriptive statistics was also used for organizing and presenting the data of the identified fungus. Most of the farmers 70-80% picked fully or over ripped tomatoes with hands that was not stored for more than two or three days. The respondent farmers using different methods of transportation, 38% of them using carts, 10 – 12% Isuzu and 40 – 50% (n = 210) carry by themself to markets. It was observed that a loss of 13.22, 20.17, 17.22, 14.30 and 38.88% were recorded visually at harvest, market, storage, transportation, packaging and in field due to diseases. Five genera of fungus were identified from the surveyed tomato samples. The mean incidence of Alternaria species was high 56.36, 60.28, 40.00 and 52.00% in east Wollega, west Shewa, north and south Wello, respectively. The mean frequency of Alternaria and fusarium species were 40 and 51% in the samples collected from east Wollega and west Shewa. From this research it was concluded that the farmers not used appropriate harvesting time, favorable packaging materials, modern storage technology, attention was not given in all the supply chains for reducing post-harvest losses. Therefore, multidisciplinary works especially on the uses of modern storage technologies and marketing systems are required to reduce post-harvest losses of tomato and other fresh produce. Further work is encouraged to examine the harmful effects of insecticides and fungicides applied on the tomato fruits for human health.

Key words: Disease, Frequency, Incidence, *Solanum lycopersicum*, Supply chains.

INTRODUCTION

Tomato (*Solanum lycopersicum*) is one of the popular crops in the world, including tropical countries like Ethiopia (Yusufe *et al*, 2017) In terms of acreage, tomato ranks fourth among summer and winter vegetables (Khatun *et al.*, 2014). However, the production and quality of tomato are known to be largely affected by the pathogens in the field or post-harvest processing (Walker, 1971; Ramyabharathi *et al*., 2012). Disease development during field or/post-harvest storage and shipment without the effective inhibitor of microbial growth results in huge economic loss. Fungi are the most important and prevalent pathogens that infect a wide range of host plants, causing destruction and economic loss in tomato either in the field, storage or transportation (Sommer, 1985). Also, Kader (1992) reported that one of the most common, and obvious causes of deterioration is fungal activity. Agrios (2005) suggested that post-harvest diseases caused 10-30% of the total yield of crops and in some perishable crops like tomato especially in developing countries; they destroy more than 30% of the crop yield. Hassan *et al*. (2010) reported that in Bangladesh, post-harvest loss of tomatoes estimated to be 30% in the supply chain. Earlier reports suggested that post-harvest losses of tomatoes ranged from 20 to 30% (Coursey, 1971) and 30 to 50% (Lashley, 1984). Most losses and wastes occur in the latter part of the food chain through excessive processing, packaging and marketing (FAO, 2008).

The core strategy of improving food security is reducing postharvest loss of the produce for people though saving natural resources and energy (FAO, 2016). Reducing of postharvest losses by 50%, would be improved food accessibility by 20% without cultivating an additional hectare of land for increasing crop yield (Ayandiji and Omidiji, 2011). Furthermore, there have not been many researches undertaken on the impacts of food loss in developing countries. Hence, there is a crucial need for additional quantitative researches that provide postharvest loss estimates. In developing countries like Ethiopia, greatest postharvest losses were occurred before reaching the market. Little information is available concerning postharvest

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loss of perishable produces. Inefficient pre- and post-harvest handling practices, postharvest losses and major issues of food quality are becoming major challenges in food security (Ayandiji *et al*., 2011). Therefore, the objective of this research is to isolate and identify important post-harvest diseases of tomato. To estimate post-harvest loss due to associated pathogens and toxins in tomato.

MATERIALS AND METHODS

Survey Areas and Sampling Methods

Data on physical postharvest losses were collected through interviewing and direct loss measurements through sampling. The physical loss measurements were made at packaging, transportation and storage (retailers). Ten active farmers and retailers were selected for interviews and loss estimation. Questioners were prepared to collect PHL data on important variables at postharvest storages or handling. Different storage/packages types and methods were assessed. Loss due to physical damage and diseases were measured; associated pathogens identified. Contaminated tomato fruits and unpleasant odours that make the fruits unfit for human consumption was added to a loss. A total of five zones, south Tigray, north and south Wello, east Wollega and west Shewa and forty-five woredas were assessed based on their potential tomato farming together with woreda agricultural experts to understand their views on the quality and quantity loss, causes of post-harvest and methods of storage practices used. The research design used included visual observation, loss assessment and disease identification in the laboratory. Structured questionnaires were administered through personal interviews to obtain primary and other information from farmers. A total of 210 respondents were questioned for the reasons of post-harvest losses of tomato (Map 1).

Data to be Collected

Estimation of post-harvest Losses of Tomato

Tomato fruits showing diseased, defects, sunken, deformed and shriveled were collected. The visual scoring data was according to the scales proposed by Corkidi *et al.* (2006). the scales were, 1 = 0 - 1% fruit area infection (no disease), 2 = 2 - 5% fruit area infection (slight disease), 3 = 6-9% fruit area infection (moderate disease), 4 = 10 - 49% fruit area infection (severe disease) 5= 50-100 % fruit area infection (very severe disease)

Isolation and Identification of Pathogens

small sections of infected fruit were cut and surface sterilized individually in 2% sodium hypochlorite for 1 min and rinsed twice in sterile distilled water to remove the tresses of HgCl2 and then aseptically transferred to Petri dishes containing Potato dextrose agar (PDA). The plates were incubated for the growth and sporulation of fungi. Fungi were carefully isolated and the slides were prepared in lactophenol cotton blue mounting on the glass slide. The microscopic slides were covered with a cover slip and were examined under the microscope for morphological examination. The culture thus obtained was observed under the microscope for various cultural and morphological characters viz., mycelial growth, shape, size, color and microscopical characters of the fungus so as to identify the pathogen. on the basis of cultural and morphological characteristics the fungal pathogens were identified with the help of descriptions given in standard literatures (Ainsworth, 1972; Ellis, 1971; Ingold, 1974). was calculated as follows:

Disease Prevalence and Incidence

Prevalence of each disease, based on symptoms, was estimated by counting the number of locations showing tomato disease with respect to total locations (Tucho *et al*., 2014).

$$\text{Prevalence (\%)} = \frac{\text{Locations showing tomato disease}}{\text{Total Locations}} \text{ x } 100$$

Disease incidence was assessed by counting the diseased parts cut of the fruits for the plates used to the total number of fruits sampled

$$\text{Disease incidence (\%)} = \frac{\text{number of infected fruits}}{\text{total number of fruits sampled}} \text{ x } 100$$

Isolation Frequency

$$\text{IF (\%)} = \frac{\text{Number of samples of occurence fungi species}}{total\ number\ of\ sample} X\ 100$$

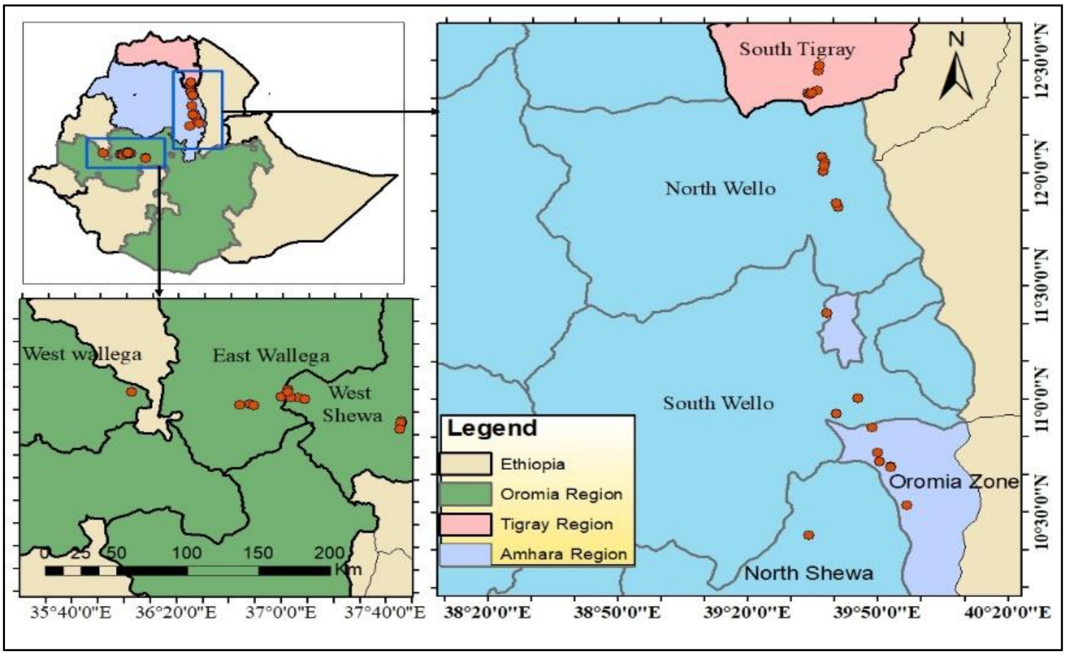
Data Analysis

The collected data was statistical analyzed using ANOVA (Analysis of Variance) of SPSS (Statistical Package for the Social Sciences) Version 26.0. and means were compared for the significant factors and significance was accepted at 5%. Descriptive statistics was also used for organizing and presenting the data of the identified fungi.

RESULTS AND DISCUSSION

Assessment of Post-Harvest Losses of Tomato at Supply Chains

Most of the farmers 50-80% picked fully or over ripped that was not stored for more than two or three days. The farmers pick the fruits with their bare hand without using glove and this made the fruits contaminate and impose infection. Also not used stalking to protect the fruits contamination with the soils. All of the surveyed tomato farmers were harvested their tomatoes on polyethylene sheet or net box in the field and collecting into wooden made box, net containers and carton (Figure 2 A). 38% of the respondent farmers were loaded the harvested tomato using carts to the direct market, 10 – 12% using Isuzu and 40 – 50% (n = 110) carry by themself to markets. Putting of harvested tomatoes in wooden box, carton, dropping and dragging causes the fruits to bump against each other. Also, the finding of Asrat *et al*. (2019) reported that the majority of farmers (95.20%) were using men's shoulder or back of women's and others used back of animals and animal drawn carts (40.80%) to transport their tomato to the local market which in both cases may result in transportation damage. Form this survey it was observed that post-harvest loss of tomato was estimated to be up to 30 – 40% from harvest to market. A physiological disorder like blossom end rot and sunburn caused up to 10-18% post-harvest loss due to consumers preferences (Figure 3). Opadokun (1987) reported that 21% of harvested tomato in Nigeria was lost due to rot in the field and 20% due to poor storage system, transportation and marketing. Likewise, Oyeniran (1988) reported that 50 % of the tomato yield was lost between rural production and town consumption in the tropical areas. Table 1 showed that post-harvest loss of tomato in



Map 1: Assessment of Tomato post-harvest diseases in Ethiopia.

Fig. 2: Visual score of post-harvest losses. A = packaging, B = sorting, C = harvesting in net bag.

Fig. 3: Visual scaling of post-harvest losses of tomato in the field due to diseases & sorting.

Table 1: Visual score of post-harvest loss of Tomato

Survey Zones	Loss at harvest	loss at packaging	loss at transport	loss at storage	loss at market	loss at the field
North Wello	8.95	6.64	7.3	8.8	14.43	15.69
South Wello	13.22	7.8	11.11	10.22	13.47	34.68
East Wollega	10	10	6.48	11.67	20.17	24.85
West Shewa	10.6	9.47	14.3	17.4	17.6	38.88
South Tigray	6.62	2.34	7.00	5.52	10.00	8.65

the market shares up to 20.17% in east Wollega due to lack modern storage, long distance shipment from the farm to the market and unfavorable loading materials during transporting. Mukaminega (2008) suggested that post-harvest losses of tomato fruits also occur on transit due to long distance to markets, poor and inadequate infrastructures and the method of transportation. It was observed that the highest 17.40, 20.17 and 38.88% of losses were recorded at storage, market and field in west Shewa and east Wollega respectively. According to the responded farmers post-harvest losses of tomato were recorded up to 75 – 100% in the fields when the disease was severed and when the farmers unable to use fungicides (Figure 3 A). Also, it was observed that the farmers picked their tomato after it was over ripened.

Isolation and Identification of Post-Harvest Tomato Diseases

Figure 5 and 6 summarize the incidence and frequency of fungus species in the samples. Five fungus genera's, *Alternaria*, *Fusarium*, *Aspergillus*, *Trichoderma* and *Rhizopus* were identified from the tomato samples surveyed. Ogawa *et al*. (1995) result showed post-harvest diseases fungi includes; *Penicillium spp., Aspergillus spp., Alternaria spp., Botrytis cinerea, Monilinia lax,* and *Rhizopus stolonifera*. It was observed that the mean incidence of *Alternaria* species was 56.36, 60.28, 40.00, 52.00 and 50% in east Wollega, west Shewa, north and south Wello and south Tigray, respectively. Consequently, the yield loss of 50-55% were caused by *Alternaria and Fusarium spp.* if the farmers were not used fungicide and sprayed lately the loss reached up to 85%. However, Douglas (1922) explained that *Alternaria* rot has been considered a common disease and causes huge losses to tomatoes thus making tomatoes unfit for consumption. Likewise, Jones *et al*. (1993) reported that in developing countries, the production of tomato is limited by rotting which is caused by *Alternaria alternata* or Botrytis cinerea. Furthermore, Asrat *et al*. (2019) survey result revealed that *Phytophthora* infestans causes a postharvest loss of 3.28%

Fig. 4: Visual scoring of losses. A = Blossom End Rot, B = Fusarium Soft Rot, C = Sun Scorch.

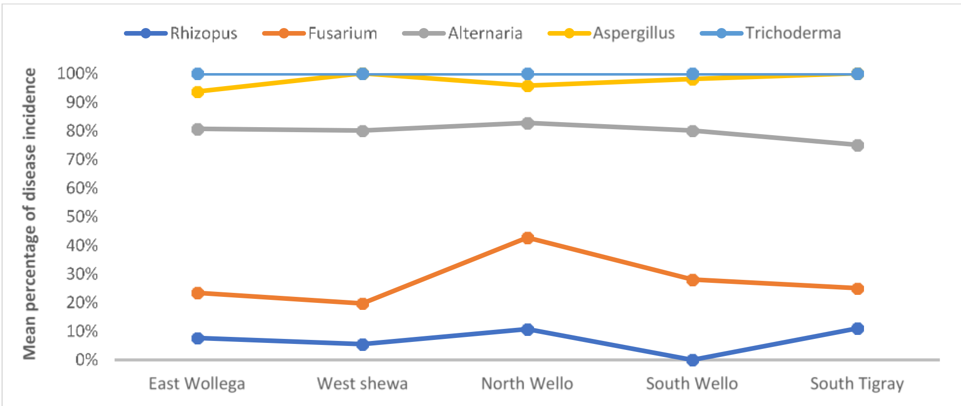


Fig. 5: Tomato post-harvest disease identified in the laboratory.

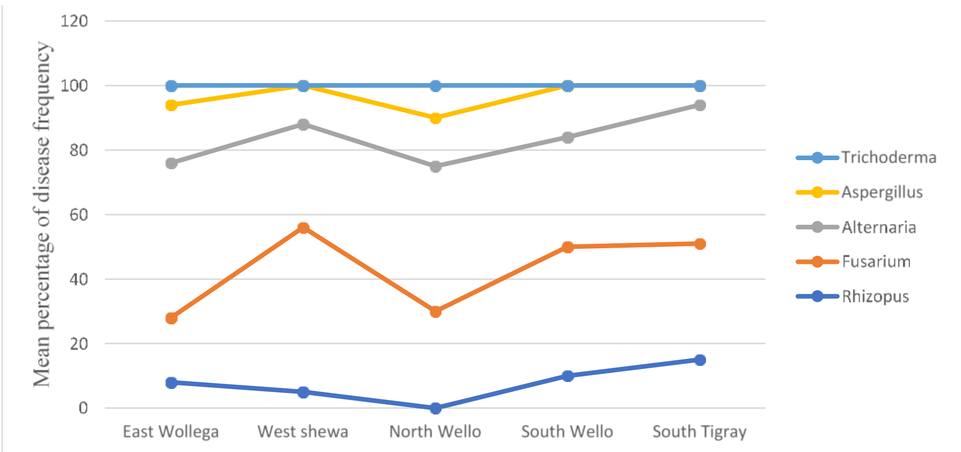


Fig. 6: Tomato post-harvest disease identified in the laboratory.

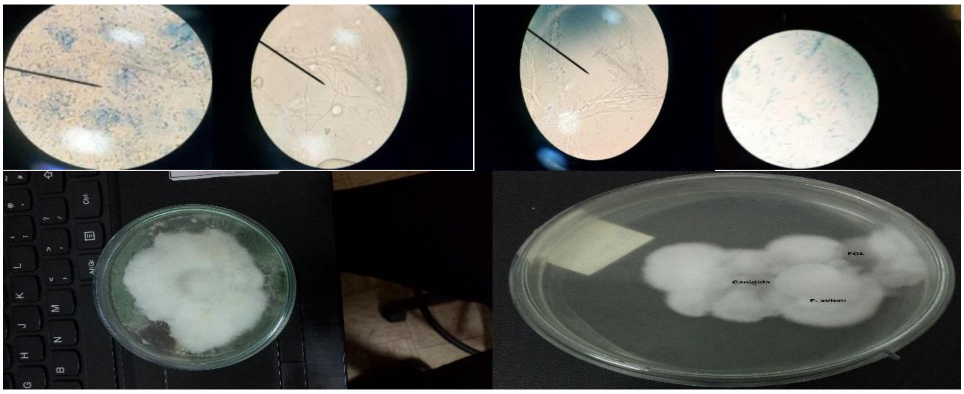


Fig. 7: *Fusarium* species identification under microscope.

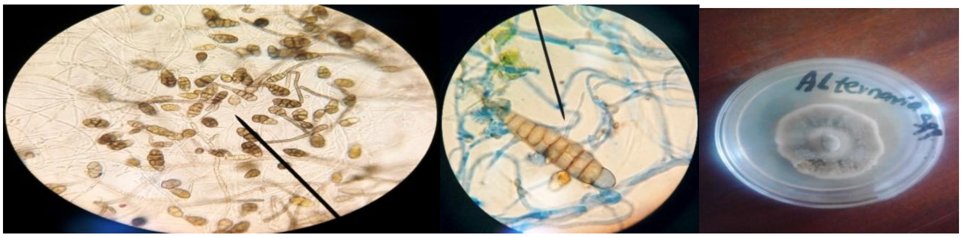


Fig. 8: *Alternaria* (Phytophthora) species identification under microscope.

Fig. 9: *Aspergillus* species identification under microscope.

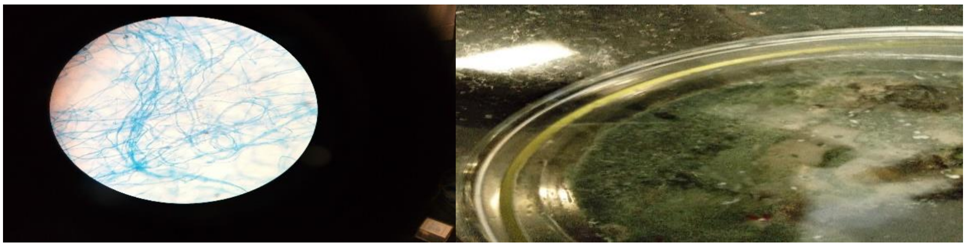


Fig. 10: *Trichoderma* species identification under microscope.

as per sample analysis result. *Fusarium* species was evolved secondly with the mean incidence of 32.00 in the samples collected from east Wollega and west Shewa. According to Kantor *et al*. (1997), approximately 23-25% and 31-38% of harvested fruit are lost to postharvest spoilage in the USA and the world respectively. The mean frequency of Alternaria and fusarium species were 40 and 51% in the samples collected from east Wollega and west Shewa, respectively. *Alternaria* and *Fusarium* rot was the two the important diseases observed during the survey that cause huge loss to the farmers at harvest and in the storage. From the survey it was observed that 10 – 18% of the tomato were lost due to blossom end rot which is the deficiency disease of calcium in the soil and sunburn in the field (Figure 4 C). These two diseases were managed by the application fertilizers and staking the tomato.

Conclusion

Most of the farmers pick their tomato fruits with hands without using any contamination protective and this made the fruits to be infections. Five fungus genera were identified from the samples in the laboratory. The incidence *of Alternaria* species was high in all the samples surveyed and followed by *Fusarium* rot which was occurred with high mean incidence in east Wollega and west Shewa. *The frequency of Fusarium* species was high in the samples collected from west Shewa. In this survey, it was observed that the farmers used fungicides and insecticides to protect their tomato from diseases and insect pests. Then, picks the fruits with the residual chemicals and bring to markets after two or three days of application and this causes toxic and harmful to human and animals. Almost, all of the tomato farmers sale their fruits with low price because its short shelf life. Because of favorable environmental condition for the disease development, poor packaging materials used, lack of good means of transportation and lack of appropriate storage technologies are the major problems. From this research it concluded that: the farmers not used appropriate harvesting time, not used favorable packaging materials, not used modern storage technology, attention was not given in all the supply chains for reducing post-harvest losses. Therefore, multidisciplinary works especially on the use of modern storage technologies and marketing systems in order to reduce post-harvest losses of tomato and other fresh produce. Further work is encouraged to examine the residual effects of insecticides and fungicides on the human health.

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