Journal of Multidisciplinary Engineering Science and Technology (JMEST)
ISSN: 2458-9403
Vol. 3 Issue 4, April - 2016

On Farm Evaluation of Mechanical Coffee Demucilager in Jimma Zone

Dubale Befikadu
Oromia Agricultural Research Institute (OARI)
Jimma Agricultural Engineering Research Center
Jimma, Ethiopia
dubebefikadu@gmail.com

***Abstract*—Coffee is an economically important crop, which is contributing the highest of all export revenues in Ethiopia. It is also the major cash crop of Jimma Zone and produced in eight woredas. Taking its economic importance in to account, Jimma Agricultural Engineering Research Center evaluated the performance of GMSE (Girja Micro and Small enterprise) model mechanical coffee demucilager with respect to conventional washing methods to address problems encountering wet coffee processors on the final quality of wet processed (washed) coffee. Wet coffee washing and performance evaluation of conventional and GMSE mechanical coffee demucilager methods was conducted on the selected existing wet coffee processing industry/sites in the zone during the harvesting season of 2014. The physical and organoleptic quality attributes were analyzed by three trained coffee panelists at Jimma Agricultural Research Center. No statistically significant (P>0.05) effect was observed between the wet coffee washing/processing method used on raw value, cup value and total quality attributes. The result revealed that the mean values for bean shape & make, color, odor and total raw value were 12.58, 12.00, 9.00 and 41.65 respectively during conventional coffee washing method. While washing by demucilager, the mean values of 11.83, 11.75, 9.17 and 32.75 were recorded respectively. The mean cup value recorded were 41.65 and 43.59 while mean total value were 75.23 and 76.34 for the conventional and demucilager coffee washing methods respectively. The demucilager statistically showed a non significant difference (P>0.05) in terms of total quality value for the tested beans sample over the conventionally washed one. The washing capacity by GMSE demucilager and conventional coffee washing method was 39,823 kg/hr and 4,286 kg/hr while the water consumption was 0.67 Lt/kg and 2 Lt/kg respectively. It can be concluded that GMSE coffee demucilager has better performance than conventional wet coffee washing method in terms of washing capacity, labor-hour and water consumption reduction. Demonstration and pre-scaling up of this improved technology is therefore recommended for its mentioned merits.**

Keywords—Coffee; Wet Processing; Demucilager; Conventional Washing; Washing capacity

I. INTRODUCTION

Coffee is the major source of foreign currency for Ethiopia and contributes more than 35% of the total export earnings [1]. Thus, it is a cornerstone in the export economy of the country and it supports directly or indirectly the livelihood of some 15 million people [2]. Jimma Zone is one of coffee growing zones in the Oromia Regional State, which has a total area of 1,093,268 hectares of land [3]. Currently, the total area of land covered by coffee in the zone is about 105,140 hectares, which includes small-scale farmers' holdings as well as state and private owned plantations. Out of the 40–55 thousand tons of coffee annually produced in the Zone, about 28-35 thousand tons is sent to the central market, while the remaining is locally consumed [3, 4].

Now a day, Jimma Zone covers a total of 21% of the export share of the country and 43% of the export share of the Oromia Region [3]. Despite the favorable climatic conditions, variety of local coffee types for quality improvement and long history of its production in Jimma Zone, coffee quality is declining from time to time due to several reasons. This is still practiced by the majority of coffee farmers and/or traders, from which the larger portion of the produce is obtained. These quality problems are mainly associated with improper post-harvest processing and handling practices such as drying on bare ground, improper wet processing, storage and transportation, poor agronomic practices like uncontrolled shade level,

lack of stumping, pruning and weeding, poor harvesting practices, such as stripping and collecting dropped fruits from the ground [5]. Coffee processing is a very important activity in coffee production system and playing vital role in quality determination [6]. The quality of Ethiopian coffee is determined by two main factors namely the geographic origin and the postharvest processing techniques [7, 8]. Physical and organoleptic qualities are the most important parameters in the world coffee trade. It is estimated that the quality of coffee is determined by 40% in the field, 40% at postharvest primary processing, and 20% at export processing and handlings including storage [7, 8]. This underscores the importance of primary processing in enhancing the quality and value of coffee.

Among the problem of post-harvest processing and handling, wet coffee washing after fermentation being practiced in the study area to facilitate the removal of mucilage is one in which the pulped coffee is soaked to be fermented naturally in a concrete storage tanks where it is kept for 24 to 40 hours. The fermentation is followed by washing through scrubbing the soaked beans against the concrete floor passage manually requiring 3 to 4 rinses of clean water to remove all traces and decomposed products of the mucilage which is time consuming and laborious activity [9]. However, mechanical demucilaging process allows the quick removal of the mucilage with many advantages compared to the natural fermentation process. Some of the advantages reported by Ethiopian Science and Technology Agency include significant reduction of human labor required for the operation, maintenance of coffee quality, saving of foreign currency that would otherwise be used for the import of mechanical demucilagers and significant reduction in the consumption of water [10]. The existing coffee mucilage removal method practiced around the study area is mainly the natural fermentation process mentioned above. Taking these problems in to account mechanical coffee demucilager was developed by Girja Small and Micro Enterprise. However, complete information regarding the complete result of this demucilager with respect to conventional wet coffee washing (processing) has not been fully documented to be introduced to coffee growers in the study area. So, on farm evaluation of this technology for the maintenance of wet processed coffee quality was found important

Objectives of the study

- To evaluate performance of GMSE model mechanical coffee demucilager

II. Materials and Method

Coffee demucilager was procured from GMSE and installed on the existing wet coffee processing (washing) sites at Yebu, Jimma zone selected based on wide production of coffee for wet processing and presence of coffee pulpers already installed. Handpicked bulk of coffee were pulped using disc type coffee pulper that squeezes the berries between fixed and moving surfaces after which it was soaked in to fermentation tanks for three days. After three days GMSE mechanical demucilager was installed on the existing 3m x 2.3m x 1.2m fermentation tank containing 15,000 kg pulped coffee beans. Water was allowed to fill up to neck (about 0.50m below the top edge) of tank and demucilager was mounted on hollow square pipe and placed on edge of 0.25m thick wall of the fermentation tank before it was arranged to run on to nine equidistant grid points on the tank shifting it to these points every three minutes one after the other to attain uniform washing throughout the fermentation tank.

During conventional washing method, the soaked beans were allowed out of the tank in to washing canal built adjacent to fermentation tank where six operators scrub the beans against the concrete canal using wooden tool. The beans were washed using three changes of clean (rinsing) water during conventional method for rinsing using four operators which the demucilager method needed a single rinse

and four operators to remove all traces and decomposed products of the mucilage. Hand fill texture method was employed to check for the removal of mucilage in between washing during both wet washing methods. The wet parchments coffees were placed on mesh wire under sun for drying. From each of dried parchment coffee 1 kg was taken, sealed in plastic bag and kept in a well ventilated room at 20°C and relative humidity of 60% until taken to laboratory for physical and organoleptic quality analysis. The wet parchments coffees were then placed on mesh wire under sun for drying. During drying the moisture content of the bean was measured using digital moisture tester (HE-50) to check and maintain the moisture level between standard value of 10.5 and 11.5% for all samples uniformly [11]. The dry parchment coffee was put in plastic sample bags, assigned with an arbitrary code and stored in a well ventilated room at about 60% relative humidity and 20ºC temperature till cup testing. Stored coffee samples were taken to JARC laboratory and hulled by hand, polished to remove the parchment and silver skins from the green coffee.

Sample preparation

About 300g of green coffee bean sample were prepared for each treatment and replication for bean physical and organoleptic quality analysis. To obtain uniform bean size for bean physical and organoleptic quality analysis, samples were screened through mesh sieve size.14. Samples on and above screen No.14, defined in the International Organization for Standards [12] were used for analyses.

Data collection

For laboratory analysis moisture content, acidity, body, flavor, odor, shape and make and overall quality characters were recorded as quantitative bean quality attributes.

Bean physical and organoleptic quality analysis

Following the procedures of JARC and [13] (Coffee Liquoring Unit of Ethiopia), physical and organoleptic quality analyses of demucilaged bean was carried out at JARC laboratory by well trained cup testers.

Roasting

The roaster machine with six cylinders (Probat BRZ6, werke, Von Gimborn Gmbhan Co. KG) was first heated to about 160°C-200°C. About 100g green coffee beans sample per each replication were put into the roasting cylinder and roasted for an average of seven minutes to medium roast. The medium roast coffee was tipped out into a cooling tray and allowed to cool down for about four minutes rapidly by blowing cold air through it. When the roast was cool it was blown to remove the loose silver skins before grinding.

Grinding

About 12g medium roasted of each sample was weighed and ground using roasted coffee electrical grinder (MahlKonig, Germany) with middle adjustment. Then 8 g coffee powder was put into a clean standard porcelain cup (three cups per sample unit) with 180ml capacity (Schonwald, Germany).

Brewing

Fresh boiled water was poured into the coffee up to about half of the cup. The ground coffee was inspected and nosed for some undesirable smells. Then, the contents of the cup were stirred to ensure a complete infusion of the ground coffee and the cup was filled to full capacity with boiled water. Then, the cup was left for about three minutes, allowing the coffee to brew. The foam was skimmed off with spoon and the cup was left to cool down to a temperature 60^{o}C. The brew was made ready for panelists within 8 minutes, for cup test analysis.

Cup tasting

Five cups per sample in three replications were prepared for each tasting session. The samples replicated for each sample were arranged at random. The sensory evaluation of each sample and the cup

quality was carried out by a panel of JARC three liquorers. A spoonful of the brew was sucked with air into mouth of a taster and held at the back of the tongue between the tongue and the roof of the mouth where the tasting glands are located. It was held in the mouth and moved around for 7 to10 seconds for sensory evaluation, which involved taste for cleanliness of the cup (defective cups including foul, musty, earthy, chemical, etc.). Cup quality evaluation consisted of raw (40%) and liquor (60%). Raw value was evaluated as shape & make, color, and odor. Liquor was also evaluated as acidity, body and flavor. Finally mean of each variable by the panel was used for statistical analysis.

Grading

Green bean coffee samples evaluation and grading for both raw (40%) and liquor (60%) quality was carried out for eight samples following the procedures of [14]. The overall standard for raw and cup quality grades of washed coffee range from 1 to 9, where, grade 1 = 91-100%, grade 2 = 81-90%, grade 3 = 71-80%, grade 4 = 63-70%, grade 5 = 58-62%, grade 6= 50-57%, grade 7 = 40-49%, grade 8 = 31-39%, grade 9 = 20-30% [15,14].

Experimental materials

The experimental materials used for the study were local variety of coffee samples collected from Manna, Jimma zone (Fig. 2) and electrically driven (5.5 KW electric motor) GMSE coffee demucilager (Fig. 1).

Fig.1. *GMSE Coffee demucilager (left) and Conventional wet coffee washing (right)*

Fig. 2. *Wet processed coffee samples ready for physical and organoleptic quality analysis.*

Method of Data Analysis

Completely randomized design (CRD) was employed with four replications. The collected data was subjected to one way analysis of variance (ANOVA) using SPSS version 20 and the significance was accepted at 5% level.

IV. Result and Discussion

Physical Coffee Quality Attributes

Physical coffee quality attributes (Bean shape and make, color and odor) is presented on Table I. Bean shape and make, color and odor between the processing methods showed no statistically significant (P>0.05) difference. During conventional coffee washing method the mean values for bean shape & make, color, odor and total raw value was 12.58, 12.00, 9.00 and 41.65 respectively. While washing by demucilager the mean values for bean shape & make, color, odor and total raw value was 11.83, 11.75, 9.17 and 32.75 respectively.

TABLE I. INFLUENCE OF WET PROCESSING METHODS ON RAW VALUE QUALITY PARAMETERS OF WASHED COFFEE

Processing methods	Shape & Make	Color	Odor	Raw value* (40%)
Conventional Method	12.58	12.00	9.00	33.58
GMSE Demucilager Method	11.83	11.75	9.17	32.75

**Means of 12 observations.*

Organoleptic Quality Attributes

Results on influence of wet processing methods on organoleptic quality of washed coffee are presented on Table II.

TABLE II. INFLUENCE OF WET PROCESSING METHODS ON CUP VALUE QUALITY PARAMETERS OF WASHED COFFEE

Processing methods	AQ	AI	AC	AS	BI	BO	FL	OAQ	Cup value * (60%)
Conventional Method	4.00	3.83	6.58	3.75	3.83	6.83	6.25	6.58	41.65
GMSE Demucilager Method	3.75	3.83	6.92	4.00	3.92	7.17	6.83	7.17	43.59

**Means of 12 observations; AQ=aromatic quality; AI=aromatic intensity; AC=Acidity; AS=astringency; BI=bitterness; BO=body; FL= flavor; OAQ=overall quality*

Wet coffee processing methods used had also showed no statistically significant (P>0.05) effect on cup value quality parameters; Aromatic quality (AQ), Aromatic intensity (AI), Acidity (AC), astringency (AS), bitterness (BI), body (BO), flavor (FL) and overall quality (OAQ) of washed coffee. The mean cup value were 41.65 and 43.59 while mean total value were 75.23 and 76.34 for the conventional and demucilager coffee washing methods respectively (Table II and III).

Total Quality Value

Though no statistically significant difference (P>0.05) was observed between the wet washing methods in the row and cup quality values, the total final coffee quality value of demucilager and conventionally washed samples was 76.34 and 75.23 respectively which fell in to grade 3 as per the standard values used for washed coffee quality evaluation and grading set by [13].

Washing capacity and water consumption of coffee washing methods

The average washing capacity by conventional coffee washing method and GMSE coffee demucilager was 4,286 kg/hr and 39,823 kg/hr respectively. The water consumption per kg of wet parchment coffee was 2 Lt/kg and 0.67 Lt/kg respectively using conventional coffee washing and demucilager methods.

TABLE III. TOTAL VALUE OF RAW AND CUP QUALITY

Processing methods	Raw value* (40%)	Cup value* (60%)	Total value* (100%)
Conventional Method	33.58	41.65	75.23
GMSE Demucilager Method	32.75	43.59	76.34

**Means of 12 observations*

V. CONCLUSION

The total quality (the sum of cup and raw quality) values of washed coffee was 75.23 and 76.34 for conventional and demucilager washing methods respectively. The average washing capacity by conventional coffee washing method and GMSE coffee demucilager was 4,286 kg/hr and 39,823 kg/hr respectively. The water consumption per kg of wet parchment coffee was 2 Lt/kg and 0.67 Lt/kg respectively using conventional coffee washing and demucilager methods. It can be concluded that GMSE coffee demucilager has better performance compared to conventional coffee washing method in terms of washing capacity, labor-hour and water consumption reduction. In addition to wet processing water consumption and labor-hour reduction, GMSE demucilager had merits in terms of affordability for users (coffee processors), saving foreign currency that would otherwise be used for the import of mechanical demucilagers. The demucilager has also advantage over use of imported demucilagers in being compatible with the existing physical structures of coffee industries avoiding re-construction of washing tank which the use of imported demucilagers might need.

VI. RECOMMENDATION

The tested GMSE demucilager is recommended as it performs better than conventional method mainly in terms of wet coffee washing capacity, considerable labor-hour and water consumption reduction. It is therefore recommended for demonstration and pre-scaling up to solve the problem facing wet coffee processors in terms of final coffee quality maintenance and drudgery reduction.

VII. ACKNOWLEDGEMENTS

The author acknowledges Jimma Agricultural Engineering Research Center of Oromia Agricultural Research Institute (OARI).

VIII. REFERENCES

[1] FAO/WFP. 2008. Special report FAO/WFP crop and food supply assessment mission to Ethiopia. 24 January 2008.

[2] EEA. 2001. Annual report on Ethiopian economy. 1999/2000, EEA, Addis Ababa, Ethiopia.

[3] JZARDO. 2008. Jimma zone agricultural and rural development office. Annual Report for year 2007/08, Jimma. Unpublished.

[4] A., Teshome, E., Kebede and K., Kebede. 2008. Coffee development and marketing improvement plan. In: Proceedings of A National Work Shop four decades of coffee research and development in Ethiopia. 14-17 August 2007, EIAR, Addis Ababa, Ethiopia. pp. 375-381.

[5] D., Nure. 2008. Mapping quality profile of Ethiopian coffee by origin. In: Proceedings of a National Work Shop four decades of coffee research and development in Ethiopia. 14-17 August 2007, EIAR, Addis Ababa, Ethiopia. pp. 328-333.

[6] J.K., Mburu.1999. Notes on coffee processing procedures and their influence on quality. *Kenya coffee*, 64(750): 2861-2867.

[7] R., Musebe, C., Agwen anda and M., Mekonnen, 2007. Primary coffee processing in Ethiopia: In Africa Crop Science Society; Africa Crop Science Conference Proceedings, 8: 1417-1421.

[8] S., Gure, A., Mohammed,W., Garedew and G., Bekele. 2014. Effect of mucilage removal methods on the quality of different coffee (Coffea arabica L.) varieties in Jimma, South Western Ethiopia. *World Applied Sciences Journal* 32 (9): 1899-1905.

[9] A., Abasanbi. 2010. Assessment of coffee quality and its related problems in Jimma zone of Oromia regional state. M.Sc. Thesis, Jimma University, Ethiopia.

[10] GMSE. 2014. Problem solving innovation outputs. Unpublished leaflet. Girja Micro and Small Enterprise. Bule hora, Borena zone, Oromia region. Unpublished.

[11] A., Sualeh and N., Mekonin. 2015. Manual for coffee quality laboratory. Ethiopian Institute of Agricultural Research (EIAR), Ethiopia

[12] ISO. 1991. International Standard ISO 4150: Available at: http://www.iso.org

[13] CLU (Coffee Liquoring Unit). 2007. Training manual for trainee coffee cuppers, coffee quality inspection and auction center, Addis Ababa Ethiopia, June, 2007.

[14] ECX. 2010. Coffee Contracts: Coffee grading parameters. Ethiopian Commodity Exchange, Addis Ababa, Ethiopia. pp 8.

[15] ECX. 2009. Coffee grading procedure. Quality control unit, Ethiopia Commodity Exchange, Addis Ababa, Ethiopia. pp.12.