Investigation of coffee seed physical purity, seed health and effect of storage time on viability

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ABSTRACT

High seed quality is essential for optimum stand establishment in Coffee. As a result, it is necessary to have seed physical, germination percent, physiological and health tests that permit rapid, objective and accurate evaluation of seed quality. This study evaluated the effect of storage time on physical, physiological, germination percent and health quality of seed lots of five coffee varieties obtained from research and commercial company. This test is conducted under ideal laboratory conditions and in the nursery site. After sample collected pure, pea-beery, cracked and shriveled seeds were measured before determining standard germination and vigor. The highest pea berry was recorded at JARC on the variety 75227(18.63), and the lowest was at LCP on the variety 74165 (8.81). In parchment coffee seed, the percentage of physical defects during seed processing affects germination and seedling viability. The standard germination test in the moisten-soft paper continues to be the most common measure of seed quality in coffee. In addition, this test requires more than two weeks before a determination of seed germination was possible. Ideally, seed quality tests efficiently differentiate between poor and good seed lots in a short period. There was high germination percent in the first planting time were recorded after one month storage than other two consecutive storage time. Normal germinated seedling reduced with in increases seed storage time and the incidence of seed/ soil -born pathogenic fungi. The germination test of seeds from laboratory under petri-dish with moist soft paper and at the nursery site also had low vigour and did not produce suitable seedlings for planting evaluated after three month storage. If after one month storage time of coffee seeds germinated more than older seeds (as our study indicates), then seedlings derived from younger may have a competitive advantage over seedlings derived from older one. In the present study, pre-emergence seedling mortality (Rotten) was greater in third month storage than in first month old seeds. This mortality partially accounted for the lower germination percentage in three month old seeds because only seeds that emerged above the soil surface were considered to have germinated is an indication of reduced vigor. In my study, in coffee seeds, seedlings from relatively low stored seeds were generally better able to withstand environmental stress than those from old seeds. Coffee seed sample from two sources stored safely to optimize coffee seedling production at the appropriate time and season with ideal climatic conditions for planting in the field.

Key words: Coffee seed, germination percent, physical quality, physiological quality, storage time and seed health

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INTRODUCTION

Coffee *(Coffea Arabia* L.) is a significant agricultural product of economic and social importance for Ethiopia and is important in world agribusiness. Coffee trees are propagated using seedlings derived from seeds. However slow and uneven germination and poor storage potential slows coffee seedling development at the time and season when ideal climatic conditions exist for planting in the field in the principal coffee producing regions. Therefore, it is highly desirable that coffee seeds be stored safely to optimize coffee seedling production. Coffee beans are the seeds from the fruit of the coffee tree. Typically, each fruit contains two seeds which face each other on their flat sides. However, a small percentage of the fruits actually contain a single, rounded seed, referred to as a pea berry (J.Martinez and Campany). The intermediate storage category has been proposed for coffee seeds based on the fact that coffee seeds survived storage for about ten months at 15°C and at 10 or 11% fresh weight basis (f.w.b.) moisture content and decreased germination was obtained with progressive reductions in seed moisture content and storage temperature (Ellis et al., 1990; 1991). Coffee is an export commodity for Ethiopia, contributing 41% of the country's total foreign exchange earnings (IMF, 2006) and about 10% of the gross domestic product. Over 25% of the populations of Ethiopia, representing 15 million people are dependent on coffee for their livelihoods (LMC, 2000). This includes 8 million people directly involved in coffee cultivation and 7 million processing, trading, transport and financial sectors (Charveria, 2001; Oxfam, 2002). There is high demand for coffee both in the local and foreign market, although coffee production in Ethiopia is constrained by a number of factors, such as lack of quality seed supply, which is mainly dominated by the informal seed sector.

Although the effect of coffee seed storage method has been studied under different conditions, variations exist among seed sources (variety, ecology etc.) in seed quality. In Ethiopia, with the outbreak of CBD in 1960s, a number of disease resistant and high yielding selections have been developed by JARC (Jimma Agricultural Research Center). The demand for improved coffee seeds has been very high and, thus, the supply could not satisfy the increasing demand. Besides, problems associated with physical quality and germination of improved coffee seeds are repeatedly reported by the users. The purpose of this study was to assess the effect of seed storage on seed vigor in coffee *arabica* L. seeds using seeds dry-stored under room temperature and humidity. Tested potential was influence on storage on each of the following parameters: seedling viability and vigor, percent germination, percent pre-emergence seedling mortality (rotten), and seedling dry weight. In addition there was assessed coffee seed heath and physical quality. In other words, this study was conducted to compare the physical attributes of coffee seeds and parameters against percentage germination within three different storage months.

MATERIALS AND METHODS

The trial was conducted at Jimma Agricultural Research Center (JARC), located at latitude of 7^0 40 ′North and longitude of 36^0 47′ East with an elevation of 1753masl. The area receives an annual rain fall of 1594.5mm. For thirty years average minimum and maximum temperature was 13.3 and 26.5 ^{0}C, respectively. Seed moisture content was

determined before storage on seeds without parchments (i.e after removal of the endocarp, the remnant of the fruit). Seeds were stored with their parchment in waterproof packages at 10°C for three months to test the potential of the seeds to produce coffee seedlings in a favorable climatic season.

Determination of physical quality:- Analytical physical purity indicates the proportion of pure seed of the species concerned in a seed lot. The laboratory analysis also identifies and quantifies impurities (pea berry, cracked, shriveled and others) that may occur in a seed lot. A sample of 1kg seed was drawn from the research center (JARC) and commercial seed producing companies (Limu Coffee Plantation) intended for planting purpose to make laboratory seed quality analysis. Quantities of submitted sample were 0.5kg and working sample was 0.25kg. Seed samples of 0.25kg from different sources were obtained for laboratory tests including purity, germination percent, physiological and health quality, then each was replicated by divided into 0.125kg. Each sample was sorted to four components that include (i) pure seed, (ii) pea berry (iii) cracked and IV) others (soil, sheathes...). The components were weighed on precision balance to the nearest two decimal places and the percentage of each component was determined (ISTA, 1996).

Germination: four subsamples of 40 seeds each (with manual removal of parchment) per plot were used for this test. The seeds of each subsample were then evenly arranged sheets of soft paper towels, moistened with water, in a proportion equivalent to 2.5 times the mass of dry substrate and subsequently placed into a 9cm petri-dish on seed germinator. The counting was performed 15days after test installation, according to Rules for Seed Analysis (Brasil, 2009), considering germinated, healthy and dead seed.

Determination of Standard germination (StG) test:- was done for all seed samples obtained from different sources (treatments). Thirteen seeds of the pure seeds component were divided into three replicates of ten seeds which were then sown on a recommended media (forest soil) collected from the research center, was air dried, manually crushed and passed through 2mm sieve to remove clods, plant roots and other foreign materials (Yakob *et al*., 1998). The sieved soil was filled to black polythene bag of 10cm wide and 20cm length. One seed was sown per polythene bag. Every routine nursery activity was applied uniformly to all experimental units as per the recommendation. In order to determine the germination percentage seedlings were grouped into (i) normal seedlings (ii) abnormal seedlings (iii) un-germinated and (iv) Rotten and/ or dead seeds (germination did not occur; were not either hard or dormant; were generally flabby and/or infected with microorganisms; and have not presented any signal of germination).

Seedling vigor index (SVI) data was taken to determine the variation in vigorosity among seedlings of different treatments using the formula described by Abdw-Baki and Anderson (1973) as follows:

SVI = SH X G X TRL X E%

Where, SH is sample seedling height, G is girth of the sample seedling, TRL is tap root length of the sample and E% is emergence percent of the treatment. The quality of coffee seedlings produced from the stored seed was assessed in the nursery by the following: emergence percentage (final stand) and seedling developmental parameters (number of pairs of true leaves, stem diameter, seedling height, leaf area, root and canopy dry matter). The total number of emerged seedlings after sowing in each experimental plot of 30 coffee seedlings at the "jaguar ear" stage was expressed as a percentage. Means of six seedling height from each sample were calculated and the result expressed in centimeters per seedling. Length and width of one leaf of each pair of true leaves were measured and the

leaf area of each pair of leaves obtained by multiplying the width × length × 0.667 × 2 (pair of leaves) proposed by Barros *et al*. (1973).

Figure 1: Coffee seedling at the nursery site

Root and canopy dry weight determinations for the coffee seedlings were obtained by removing the coffee seedlings from the bags, washing the root system in running water and the roots were separated from the canopy by cutting the stem at the Culm; the weights of the root system and canopy were obtained after drying in a forced air chamber at 60°C to constant weight and the mean results expressed in gram per coffee seedling.
Seed-borne pathogens were assessed by subjecting all samples to surface-sterilization with agar plate method. Ten seeds were plated on a 9cm petri-dish, and then incubated at a temperature of 22^{o}C for twenty three days in potato dextrose agar (PDA). Colonies color and diameter, Probable species, adage/shape, texture, margin and elevation with six consecutive days were identified using compound microscopes.

Figure 2: Placement of Coffee seed using agar plated on petri-dish.

Data Analysis: The treatments were laid out in complete randomized design (CRD) for the laboratory and germination percent. Collected data of physical purity from the laboratory were subjected to analysis of variance as per the design of the experiments using SAS and the treatment means were separated using Least Significant Difference (LSD). The treatments assigned randomly and each treatment was replicated three times for laboratory germination and seed health test. Standard germination and physiological quality parameters of collected data at the nursery were calculated results were expressed in percentage.

RESULTS AND DISCUSSION

Analytical physical purity

The highest percentage of pure seed was recorded at JARC on the variety 74110 than LCP. The lowest percentage of pure seed component was measured at LCP on the variety 74110. Other important seed components were Pea berry, cracked and others {soil particle, coffee ruminates "*geleba*" recorded all seed collected from research center and commercial coffee seed production sites. Pea berry measure the higher seed components than cracked and others. For instance, the highest pea berry was recorded at JARC on the variety 75227(18.63), and the lowest was at LCP on the variety 74110 (9.14). Seed samples from LCP on the variety 74110 had the heights cracked seed (17.82) the lowest was recorded at JARC on the variety 744. Other seed contaminates like coffee physical defects, sheathes and soil particles was recorded at JARC on the variety 75227 i.e. 0.54 than others (Table 1).

In contrasted to other crops coffee seed not have other noxious weed. The coffee seed preparation process may cause damage and lower the quality of the seeds, since it is generally carried out with humid seeds in apparatuses, in which the exocarp and mesocarp were removed from the fruit through friction and attrition. Coffee seed drying the most case sensitive, silk part of seed removed or cracked by direct sun light.

Fagundes et al. (2009) observed that coffee seeds mechanically damaged by the use of peeling machine present impaired germination, and that significant lower germination values are found when they are compared to the germination achieved by the unharmed seeds. Similarly, a high level of contamination with dirt, stones, and weed seeds would greatly reduce the value of the seed to farmers (Nicholas *et al.,* 2007). In parchment coffee seed the percentage of physical defects during processing it affects germination and seedling viability. So, analytical physical separation of all unnecessary material like deformed seed shape, large or small and addition of unripe fruits during picking time is case sensitive before seed preparation or processing time.

Regarding the final product all seed before distribution to farmers and other stakeholders full fill all the pure seed component and must be uniform in seed size (cleaning by mechanical or hand), uniform in seed color (take care of during harvesting by picking only red cherries, adjusting machineries during processing for removing of any type of defects. Thus, defected type of coffee seed influence the growth and development of seedlings. Contamination might have been occurred during pre-harvest and post-harvest activities of seed production, harvesting, threshing, or poor storage conditions.

Generally, the incidence of the pea beery, cracked and others in terms of their presence in some of the samples is more important than the crude results of analytical purity. Hence, those were the most important factor that influenced the physical purity of the coffee seed in the germination and other physiological coffee seed quality. Carvalho and Nakagawa (2000) and Bewley and Black (1994) define the mechanical damage as the damage caused by physical agents during the harvest, processing, storage, transport and planting procedures, producing attrition, cracks, cleavage and breakage in the seeds, with a direct correlation with the reduction of germination, emergence and vigor, as well as the storage potential of the seeds.

Table 1: Analytical physical purity test

Seed sample	Composition by weight %			
	Pure seed	Pea beery	Cracked	Others
J744	79.75^{cd}	17.27^{ab}	2.5^{f}	0.47^{ab}
J74158	88.72^{a}	10.57^{c}	0.45^{g}	0.26^{de}
J74110	90.27^{a}	9.14^{c}	0.36^{g}	0.23^{de}
J74165	83.58^{bc}	15.72^{b}	0.26^{g}	0.43^{abc}
J75227	74.23^{fgh}	18.63^{a}	6.6^{cd}	0.54^{a}
74165L	86.79^{ab}	8.81^{c}	4.1^{e}	0.27^{de}
744L	76.43^{efg}	15.43^{b}	7.85^{b}	0.29^{de}
74158L	79.69^{cd}	15.0^{b}	5.02^{e}	0.25^{de}
75227L	77.46^{def}	14.81^{b}	7.36^{bc}	0.35^{bcd}
74110L	71.0^{h}	10.7^{c}	17.82^{a}	0.47^{ab}
Mean	**79.41**	**14.67**	**5.57**	**0.35**
CV %	**2.47**	**12.2**	**7.67**	**16.99**

Figures followed by in the same latter in the same column are not significantly different among each other. J = Seed samples from JARC, L = seed sample from Limmu coffee plantation.
Hassan (1995) found that 82.3% of the wheat seed samples were contaminated with barley seed in Jordan. Zewdie (2004) found significant differences in physical purity, other crop seed and weed seed contamination of wheat seed samples collected from different sources in Ethiopia attributed to the different ways that farmers used to produce, select, save and acquire wheat seeds.

Percent germination

From the first planting time of coffee seed after storage the higher germination was recorded at JARC on the new improved varieties of coffee seed 7576 (97%), the lowest at LCP seed supply on the variety 744 (70%). The result indicated that, standard germination test with moist soft paper the total average mean 89.94% from different coffee varieties at the first planting time after one month storage was higher than other two consecutive months. The first month planting of coffee seed after storage time were increases by 3.8% than the next second planting time (Table 2). The second planting time of coffee seed was increased by 4.09% as compared to the third planting time after storage. Typically, freshly harvested green coffee seeds take about 2½ months to germinate (http://www.ehow.com/how_7710576_grow-green-coffee-seeds.html).

Figure 3: Coffee seed germination on petri-dish

The value of germination percent, abnormal seedlings, un-germinated and rotten or dead seeds in a working sample during germination at the nursery site was also recorded with in a time interval (Figure 1). The first planting time after one month storage there was high germination percent than other two consecutive months. Normal germinated seedling reduced with in increases seed storage time. As the result indicated sample collected from JARC, normal germinated seedlings decreases by 18% within increases the storage time by one month (Appendix Table 1).

Therefore, when stored beyond two months, they reveal a decline in percentage germination give variable and poorly developed seedlings. According to Marcos-Filho (2005) the seed deterioration is a process induced by a series of physiological, biochemical, physical, and cytological changes, which initiates starting from the physiological maturation and occur in a progressive manner leading to reduction of their quality.

Table 2: Coffee seed germination test with in petri-dish (soft - paper)

		Planting date		
Location	**Variety**	**Date 1**	**Date 2**	**Date 3**
Jimma	744	84	81.83	78
Jimma	74158	95	89.65	84
Jimma	74110	94.25	93.54	90
Jimma	74165	96	93.75	91
Jimma	75227	82	78.125	73.75
Jimma	7576	97	92	90
Jimma	7514	94	90	84
Gera	7576	89	85	81
Gera	7514	93	89	85
Limmu	744	70	62.5	60
Limmu	74158	90	82.76	76
Limmu	74110	85	80	74
Limmu	74165	95	94.74	92
Limmu	75227	95	93.1	90
Average		**89.94**	**86.14**	**82.05**

Date one, day two and day three = days of coffee seed stored after one month, two month and three month.

The sample collected from LCP normal germinated seedlings reduced by a month about 22% (Appendix Table 2). Coffee seed viability and vigor reduced within the increases of the storage time. Normal germinated seedlings more in the first month than the last two but the reverse was true in rotten seeds and also normal germinated seedling was larger the first months of planting time as compared to in seed samples from LCP seed sources (Appendix Table 1 & 2). Even though coffee seeds are capable of germinating as soon as harvested due to absence of dormancy, they lose their viability quickly (Coste, 1992).

Ab-normal germinated seedlings increases after two months and three month storage period. There were four varieties from JARC and all variety of Limmu coffee plantation had un-germinated seedlings with in the first month of planting time. The last two months which indicated that, there was no un-germinated seed but there was higher number of rotten seed recorded. Ub-normality there was recorded with in the second and third storage time but there was little difference between the two seed samples. The higher rotten seed was recorded in the last two storage time in all seed samples.

Furthermore, seed samples from JARC the third storage time greater than by 10% rotten seed than second storage time; LCP the third storage time was higher than the second by 23%

(Appendix Table 1 and 2). Coffee seed planted recommended planting season in JARC (November - December) slow, non uniform germination, difficult to obtain easily normal germinated seedlings at a time. From sowing to time of transplanting Arabica coffee requires 6 to 8 months at nursery in warm regions and even 12 months in higher altitudes (Cambrony, 1992).

The average normal germinated seedlings were greater than 90% in all coffee seed varieties in the first months of storage time than others storage time. The first storage time, from JARC seed samples there was no ub-normal, un-germinated and rotten seeds, the reverse were true seed sample from LCP (Figure 4).

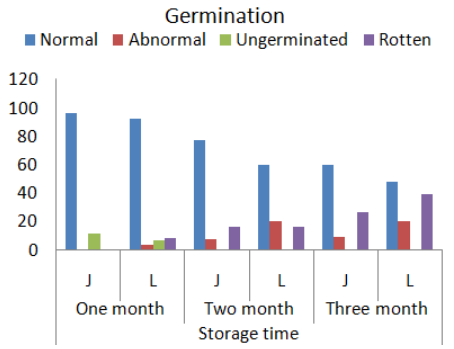

Figure 4: The effect of different storage time on coffee seed germination

Seed vigor test

Leaf number and root dry weight were not significantly different between varieties. Vigor of coffee seed was height on the variety 74158 and three varieties of coffee seeds was lower (744, 75227 and 74165); other three varieties medium values was recorded. Coffee seed vigor was significantly different between storage times. The heights vigor was recorded at the first planting time than others.

Coffee seed viability it depends on seed size, physical quality, seed health, storage time and materials. Shoot length was not significantly different between planting time. The heights shoot length, leaf number and area of leaf width was recorded on the last planting month (Table 3). Growth rate differences in the seedling stage may have a profound effect on survival and fecundity due to asymmetric competition between plants of different sizes (Leverich and Levin 1979; Silvertown and Lovett Doust 1993).

Seed Health Testing

Processed coffee seeds from two seed sample were assessed for the presence of Penicillium, Aspergillus and Fusarium species after surface sterilization with agar. Coffee bean fungal colony character was recorded on the two coffee seed sample (LCP and JARK). The most probable species was identified with colony diameter by time interval. Colony diameter increases with the increases the number of days, for instance, on the varieties 74158 from LCP Aspergilus niger was observed after 7days diameter was also 3.5-7.6cm (Appendix Table 3). Most of fungal colony was circular and irregular in shape/edge. Elevation was also as indicated on the appendix table was flat on most of the probable species others were raised. Margin of the collected coffee seed sample was also recorded entire, undulated, fliform and curled.

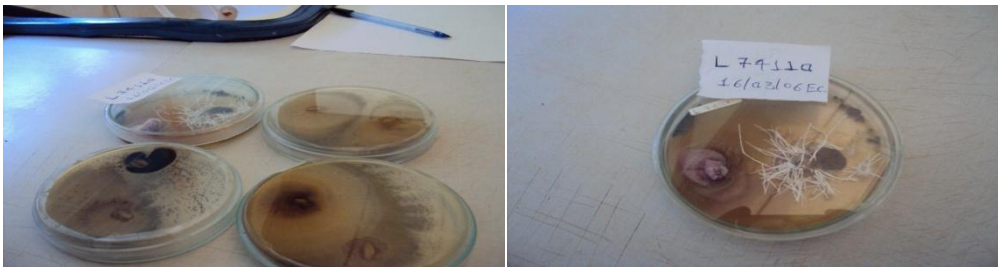

Figure 5: Coffee seed born-diseases

Figures followed by the same letter in the some column were not significantly different from each other.

Table 3: The effect of different storage time and variety on coffee seedling vigour

Seed sample	Lno	SL	RL	RN	SThic	LFW	LDW	SFW	SDW	RFW	RDW	ALL	ALW	Lar1	SVI(0000.0)
74158	9.88^{a}	20.19^{a}	20.73^{a}	35.72^{b}	3.75^{a}	8.52^{abc}	2.33^{ab}	2.68^{ab}	0.91^{a}	1.64^{b}	0.56^{a}	9.08^{b}	4.38^{ab}	26.73^{bc}	13.32^{a}
74165	9.88^{a}	19.39^{ab}	18.14^{ab}	38.61^{b}	3.70^{a}	7.74^{c}	2.29^{ab}	2.62^{ab}	0.82^{ab}	1.61^{b}	0.57^{a}	8.94^{bc}	4.29^{ab}	25.69^{bc}	10.25^{b}
7514	9.63^{a}	20.77^{a}	18.94^{ab}	40.61^{ab}	3.55^{a}	9.94^{a}	2.66^{a}	3.01^{a}	0.81^{ab}	1.96^{ab}	0.55^{a}	10.06^{a}	4.67^{a}	31.54^{a}	11.58^{ab}
744	9.44^{a}	20.18^{a}	18.41^{ab}	36.25^{a}	3.53^{ab}	9.14^{abc}	2.43^{ab}	2.77^{ab}	0.84^{ab}	1.75^{ab}	0.55^{a}	8.89^{bc}	4.63^{a}	27.83^{abc}	10.01^{b}
74110	9.17^{a}	18.82^{ab}	20.96^{a}	37.08^{b}	3.63^{a}	8.03^{bc}	2.38^{ab}	2.70^{ab}	0.85^{ab}	1.79^{ab}	0.60^{a}	8.86^{bc}	4.22^{ab}	25.25^{bc}	11.82^{ab}
7576	8.94^{a}	19.5^{ab}	20.52^{a}	36.25^{b}	3.59^{a}	9.15^{ab}	2.50^{ab}	2.98^{a}	0.90^{ab}	2.31^{a}	0.57^{a}	9.35^{ab}	4.57^{a}	28.65^{ab}	12.04^{ab}
75227	7.77^{a}	17.59^{b}	16.81^{b}	39.15^{b}	3.2^{b}	7.52^{c}	2.19^{b}	2.32^{b}	0.72^{b}	1.54^{b}	0.53^{a}	8.00^{c}	3.94^{b}	24.12^{c}	9.46^{b}
LSD (0.05)	**1.06**	**2.45**	**2.96**	**6.81**	**0.34**	**1.69**	**0.45**	**0.54**	**0.16**	**0.61**	**0.10**	**0.95**	**0.49**	**4.15**	**2.58**
03/08/05	7.34^{c}	19.27^{a}	20.11^{a}	44.34^{a}	5.38^{a}	4.82^{c}	1.25^{c}	1.46^{c}	0.39^{c}	1.21^{b}	0.31^{c}	9.72^{a}	4.39^{a}	28.72^{a}	18.59^{a}
15/09/05	9.31^{b}	20.05^{a}	19.94^{a}	39.76^{b}	2.93^{b}	11.23^{a}	3.32^{a}	4.14^{a}	1.28^{a}	2.68^{a}	0.87^{a}	8.91^{b}	4.39^{a}	26.98^{ab}	9.73^{b}
02/10/05	11.09^{a}	19.15^{a}	17.61^{b}	33.86^{c}	2.39^{c}	9.83^{b}	2.62^{b}	2.59^{b}	0.84^{b}	1.5^{b}	0.49^{b}	8.45^{b}	4.38^{a}	25.64^{b}	5.31^{c}
LSD (0.05)	**0.69**	**1.60**	**1.93**	**4.45**	**0.22**	**1.1**	**0.29**	**0.35**	**0.11**	**0.39**	**0.07**	**0.62**	**0.32**	**2.71**	**1.69**
CV (%)	**17.39**	**19.02**	**23.29**	**26.19**	**14.64**	**29.66**	**28.47**	**29.92**	**30.62**	**51.31**	**29.62**	**16.06**	**16.95**	**23.16**	**34.85**

Almost all the observed probable species (some indicated on figure 5) have rough texture others was smooth and powdery. The most frequent probable fungal colony was Fusarium spps, Aspergilus (Niger and Flavos) spps and Pencillium spps from the two seed sample. Colony colors on most of the probable spps were from the upper parts of the petri-dishe was white, light grey, blue black, dark grey and grey further more colors of colony on the reverse was white, gery, creamy, dark-grey, white creamy, dark and light creamy and deep dark (Appendix table 3). Unlike most Aspergillus and Penicillium, Fusarium species grows in crops before harvest only at high levels. Mycotoxins were therefore usually and only produced before or immediately after harvest (www.fao.org/docrep/x5036e/x5036e07.htm).

CONCLUSIONS

The crop and dirt admixture was not easily picked out by hand; no machine can select and clean. The dominance of those varieties of coffee was both interesting and worrying. Those seed samples were very good variety with many desirable attributes and widely accepted. The results showed that the physical quality of seed from JARC was equal or comparable to the seed from the LCP. The purity analysis test showed that almost all of the five varieties of collected seed samples including pea berry and cracked, were greater and which was not meet minimum national certified seed standard. So, should try to avoid all the detrimental factors such as harvesting immature seeds, faulty processing and storage techniques, can be detected even by mechanical and visual examination, the various tests done according to the international seed testing rules. Coffee seed viability and vigor reduced within the increases of the storage time. In the present study, pre-emergence seedling mortality (Rotten) was greater in third month storage than in first month old seeds.

High seed quality was essential for optimum stand establishment in Coffee. As a result, it was necessary to have seed physical quality and germination percent tests that permit rapid, objective and accurate evaluation of seed quality. The standard germination test continues to be the most common measure of seed quality in coffee. In addition, ideal laboratory test requires more than two weeks before a determination of seed germination was possible. Ideally, seed quality tests in the laboratory efficiently differentiate between poor and good seed lots in a short period. Seed quality refers to genetic purity, germination percentage, vigour, mechanical integrity, disease and pest infection, size and appearance of seeds.

A major strength in having large and small-scale seed enterprises at all level was the effective link that could form integration between variety selection, seed multiplication, distribution and use, with all stages involving the participation of all workers themselves. Main recommendation was correct site selection, good crop establishment and management, together with careful harvest and storage of the seeds were essential to ensure seed quality. Attempts have to be made by concerned institutions to popularize and disseminate other improved coffee varieties.

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Appendix Table 1: Effect of germination percent on coffee after three consecutive months storage time (JARC, seed source)

Variety	Normal			Ub-normal			Un-germinated			Rotten		
	After one month	After two month	After three month	After one month	After two month	After three month	After one month	After two month	After three month	After one month	After two month	After three month
74158	96	73	63	0	13	10	0	0	0	3	3	30
75227	100	73	43	6	7	13	16	0	0	0	16	17
74165	90	86	76	0	0	6	10	0	0	0	30	20
744	98	70	63	0	0	13	23	0	0	0	13	32
74110	95	83	53	0	17	3	7	0	0	0	20	33
	96	**77**	**60**	**0**	**7**	**9**	**11**	**0**	**0**	**~3**	**16**	**26**

Appendix Table 2: Effect of germination percent on coffee after three consecutive months storage time (Limu coffee plantation, seed source)

Variety	Normal			Ub-normal			Un-germinated			Rotten		
	After one month	After two month	After three month	After one month	After two month	After three month	After one month	After two month	After three month	After one month	After two month	After three month
74158	86	10	10	3	0	20	3	0	0	0	3	30
75227	93	96	43	0	0	2	13	0	0	43	16	65
74165	96	63	60	0	6	0	3	0	0	0	30	35
744	96	63	63	0	23	10	3	0	0	0	13	32
74110	90	76	63	0	3	3	10	0	0	0	20	33
	92	60	48	~3	6	7	6	0	0	8	16	39

Appendix Table 3: Coffee bean Fungal Colony Character Recording sheet: Date of Culture on 9cm PDA 26/02/2006

Probable spps	Variety with location	Colony Colour	Colony diameter(cm) with in day						Edge/ shape	Elevation	Margin	Texture
			7	10	13	16	21	23				
Fusarium spps	744 Limmu	Up =white	1.8	2.1	3.7	4.3	5	5.4	Circular	Flat	Entire	Smooth
Aspergillus spps	Black	Re=Creamy										Powdery
Pencillium spps	75227 Limmu	Up=Light gray	1.5	2.5	3.4	3.9	4.4	5.9	Irregular	Flat	Undulated	Rough
		Re=Dark & light creamy deep dark										
Aspergillus niger	74158 Limmu	Up=Blue black	3.5	5.1	5.2	5.9	6.5	7.6	Filamentous	Flat	Fliform	Powdery
		Re=White creamy										
Fussarium spps	74110 Limmu	Up= white	3.9	5.1	6	6.4	6.4	6.8	Irregular	Raised	Undulated	Rough
		Re=Creamy										
Fusarium Spps	74165 limmu	Up=White	2.1	3	3.6	4.8	4.9	5.3	Irregular	Flat	Undulated	Smooth
Aspergillus Spps		Re=Creamy										
Fusarium Spps	74158 Jimma	Both=Creamy	1.5	1.9	2.5	4.3	4.8	6.1	Circular	Flat	Entire	Smooth
Pencillium Spps	74165 Jimma	Up= Blue black	2.8	3	3.7	3.9	5.8	5.8	Circular	Raised	Entire	Rough
Fusarium Spps		Re=White creamy										
Aspergillus flavou		Creamy										
Pencillium Spps	744 Jimma	Up=Dark grey RE=Creamy	2	2.6	3.1	3.8	5.3	5.8	Circular	Flat	Curled	Rough
Pencilium spps	75227 jimma	Both=Grey	1.5	2	3	3.3	3.4	5	Irregular	Flat	Entire	Rough
Pencillium spps	74110 jimma	Both=Grey	1.67	2.5	3.2	4	4.2	6.5	Circular	Flat	Fliform	Rough
Fusarium spps	7576 jimma	Up=White Re= creamy	3.5	4.5	5	5.5	5	5.7	Irregular	Raised	Undulated	Rough
Fusarium & pencillium spps	7514 Gera	Both=Grey + White	2	4	5.5	6.2	7	7.3	Circular	Raised	Entire	Rough
Pencillium spps	7576 Gera	Both=Gery + creamy	1.6	1.8	2	2.3	3.2	3.2	irregular	Flat	undulated	Rough

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