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Coffee Peaberry as A Potential Seed Source for Production

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ABSTRACT

Coffee pea berry is a unique feature of coffee seed as the result of the berry producing a single bean instead of the normal two during fertilization at the field. This might happen due to three major factors i.e. failure in one of the two ovules in the ovary to be fertilized and set seed, failure in the further development of the endosperm and incompatibility of the two parents during pollination. Different coffee seed sources, types and stages were evaluated and compared with pea berries for germination and seedling growth and field performance of seedlings produced from pea berries. For most Ethiopian known coffee varieties, the potential occurrence of pea berry was also recorded for two consecutive seasons at the Jimma National Coffee Research Center with the objectives to evaluate coffee pea berry as a potential seed source and see variability among Arabica coffee varieties in terms of producing pea berries. The relevant data were statistically analyzed and treatments means were compared using SAS software. The results depicted that there was no significant variations between pea berries and normal bean with regard to germination, emergence and subsequent growth of the seedlings and yield potential yield performance under field conditions. Significant variations were observed among pre-sowing seed treatments for the parameters considered at early stage. Likewise, the coffee varieties were found to significantly differ in producing pea berry proportion with a mean value of 7% for pure lines and 16% for hybrid variety. In general, the hybrid coffee variety showed two fold higher than the pure line coffee varieties. Pea berry may not be predominantly a heritable character, because seeds produced from coffee trees raised from pea berries will not develop all in to pea berries.

Keywords: *Arabica coffee, pea berry, growth, Yield*

INTRODUCTION

In coffee, seed production is typically characterized by growth /phonological/ stage from flowering up to fruit development. Anthesis in Arabica coffee can occur on a single day or during a few days, with one or more flowerings within a single reproductive period (Wormer, 1964; Alvim, 1973). Each flowering period lasts only 2 or 3 days and is followed by intense vegetative development.

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. Coffee beans are classified as dicotyldon and usually flat on one side and transverse on the other. But sometimes coffee bear a single bean in its pod and this single bean is called pea berry. Normally, the fruit ("cherry") of the coffee plant contains two seeds ("beans") that develop with flattened facing sides, but sometimes only one of the two seeds is fertilized, and the single seed develops with nothing to flatten it.

Pea berries beans are round and oblong in shape and tend to be larger and denser. A Pea berry in coffee is the result of the berry producing a single bean instead of the normal two. It is caused by two major factors;

1. Failure of one of the two ovules in the ovary to be fertilized and set seed, and
2. Failure in the development of the endosperm.

These two conditions give the remaining seed a chance to have enough space inside the coffee to develop in to roundish shape with good endosperm development. Failure of fertilization or endosperm development in one of the ovules can be caused by various factors (Srinivasan and Vishveshwara, 1980). These are;

1. Unfavorable weather condition that cause flower abortion (environmental conditions)

2. Insufficient pollination due to failure of the agents of pollination (e.g. insect, wind),
3. Incompatibility of the two parents during pollination, a common case in inter-specific hybrids (e.g. Arabusta, a hybrid between Arabica and Robusta species), and
4. Probably genetic defects.

Coffea Arabica of the mono sperm variety has a strong tendency to produce pea berries. This is also the case for coffee hybrids where the tendency is even more marked. The presence of pea berry is considered to be a defect in coffee production and used as a criterion in coffee breeding. An increase of 1% of pea berry beans in a crop reduces production by 0.75 %(Wintgens, J.N. (2004).

Pea berries are very rare fruit, only making up 5-7% of an entire harvest of coffee beans from any plantation. On the other hand, abnormalities in coffee seed occur as elephant beans, polyspermy beans, and empty beans. To roast more evenly, because their rounder shape minimizes sharp edges and allows the berries to roll about the roasting chamber more easily, as well as because the alleged higher bean density may improve heat transfer in the roasting process. However, some source claim that these effects are minor, and that the major benefit of peaberry beans is that they have been carefully selected, which is essential for optimal quality, regardless of bean shape *(*Kenneth Davids, 2003*).*

In Ethiopia, there is no any formal system responsible for the production and supply of improved coffee seeds from the released and adaptable coffee varieties (Taye *et al.*, 2011).

The Jimma agricultural research center /JARC/ is the only governmental institution that had taken the initiative of multiplying improved coffee seeds of the nationally released coffee berry disease (CBD) resistant varieties since 1987 and distributed a total of 789230kg of improved coffee seeds which have been produced over the last three decades (1989-2017) and disseminated (Paulos, 2008; Taye et al., 2011)to all over the major coffee growing areas of the country(JARC,2017)

In Ethiopia, during coffee seed preparation pea berries seed are sort out and discard and unused as a seed to raise seedlings at nursery. Analytical purity test done by Melkam A. et al. (2014), that laboratory analysis also identifies and quantifies impurities (pea berry, cracked, shriveled and others) that may occur in a seed lot. Therefore, testing pea berries seeds for germination, emergence and grow as good seedling and consequently the bearing nature is very important. This study was undertaken with the specific objectives to evaluate the potential use of pea berry as seed source in coffee production and proportion of pea berry development in arabica coffee varieties.

MATERIAL AND METHODS

The trial was conducted at the Jimma agricultural research in south western Ethiopia geographically located 7° 7’ N and 36° E. It is situated within the Tepid to cool humid highlands agro-ecological zone of the country at an altitude range of 1753 meters above sea level. The areas receives high amount of rainfall with a long-term mean total of 1573.6 mm per annum, which is distributed into 166 days. The driest months usually last between November and February. The mean maximum and minimum air temperatures are 26.3 and 11.6 °C, respectively (JARC, 2017-old and update this weather data)

The experiment was run from November 2016 up to December 2019. Different growth nature types of coffee seed and processing stage i.e. clean coffee, normal parchment coffee; fresh cherry, partial dry cherry, green berry and parchment pea berry were prepared and evaluated for the germination, emergence and early growth performance at nursery stage according to Tesfaye et al., 2006. Coffee seedlings performance also evaluated in non destructive and destructive measurement as compare pea berry to other seed source. The pea berry seed source seedlings also transplanted and evaluated for yield at the field. Besides, few Ethiopian coffee varieties were also evaluated for pea berry proportion for two harvesting seasons.

RESULT AND DISCUSSION

After two months of sowing, clean coffee (parchment removed) had a higher emergence percentage and followed by pea berry seed. Starting from 60th days after sowing (DAS), there was a significant difference of emergence percentage among different coffee seed source, except clean coffee and pea berry seed. At 90 and 105 days, still the pea berry seed emergence increase with no significant difference between clean coffee, fresh cherry, parchment and partial dry cherry(Table1). Initially the pea berry emergency percentage was delayed from clean

coffee because of longer imbibitions period that may be required since the seed is hard enough to soak because of its well developed endosperm. Regarding germination and subsequent emergence, since the embryo development is unaffected, pea berries also can germinate and produce seedlings as of the normal seed in this study.

Table1. *Mean emergence (%) of coffee seedlings due to seed types and days after sowing (DAS).*

Seed type	Days after sowing (DAS)			
	60	75	90	105
Fresh cherry	13d	37.04 bc	66.67a	75.92b
Partial dry cherry	10e	18.52c	59.26ab	79.63ab
Green berry	11.16de	14.81 c	38.89b	62.96c
Clean coffee	40.66a	70.37 a	81.49a	87.04a
Pea berry parchment	20.33b	53.70ab	75.93a	81.48ab
Normal parchment	16.50c	38.89 bc	64.81ab	79.62ab
S.E	0.9467	8.26	8,23	5.14
C.V (%)	8.81	36.79	22.11	11.44

Means followed by same letter(s) are not significantly different at P≤ 0.05 probability level

The Growth Stage

The growth stage of different seeds source are vary, where clean coffee, parchment, pea berry and partial dry cherry were had fastest growth than fresh cherry and green berry. Clean coffee attains early to first true leaf than others at 120 days of after transplanting (Fig. 1.). At 135 DAS, the clean coffee, parchment, pea berry and fresh cherry showed better performance of growth stage than others accordingly.

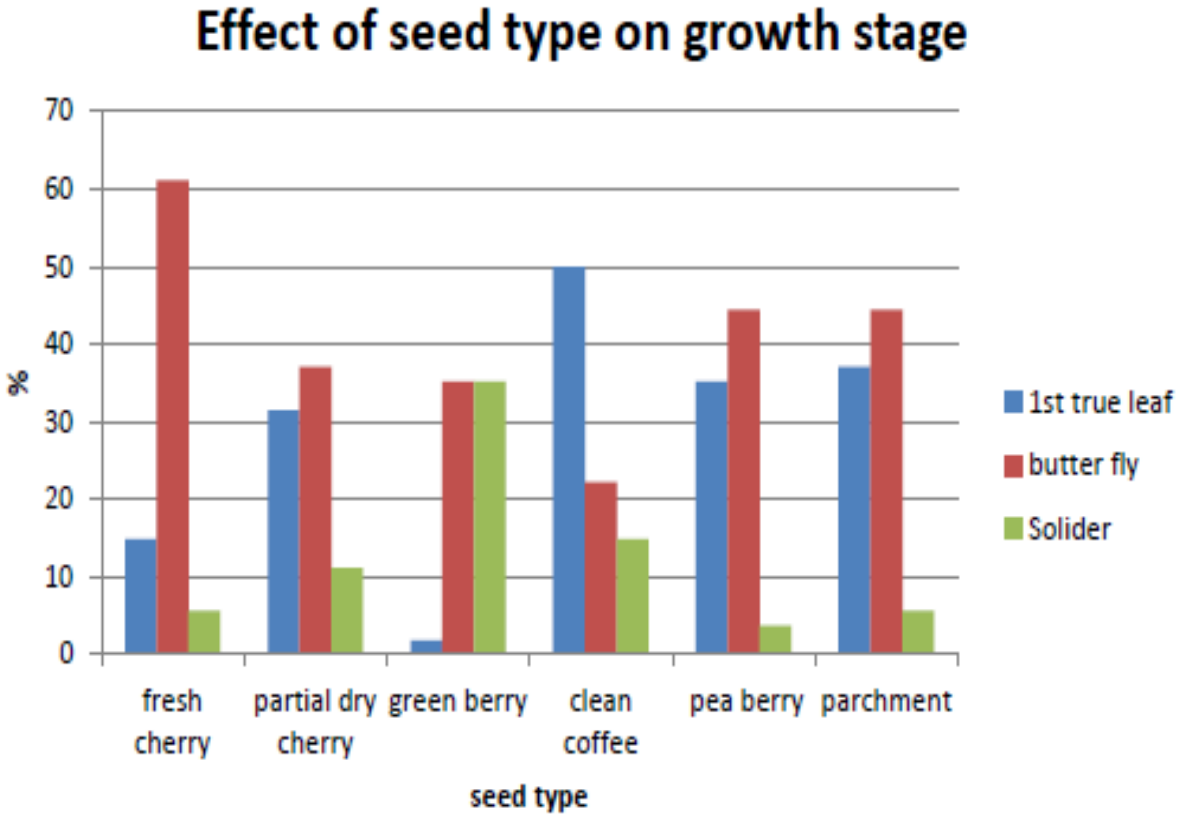

Fig1. *Effect of coffee seed source on growth stage at 120 days*

The least first pairs of true leaf growth and high percentage of solider growth stage at 120 and 135 days (Figs1 and 2) were recorded from green berry seed, indicating the much delayed rate of growth in coffee seedlings.

At 135 days, two pairs of leaves observed in higher percentage accordingly on clean coffee, pea berry, parchment, fresh cherry, partial dry cherry and green berry in that order.

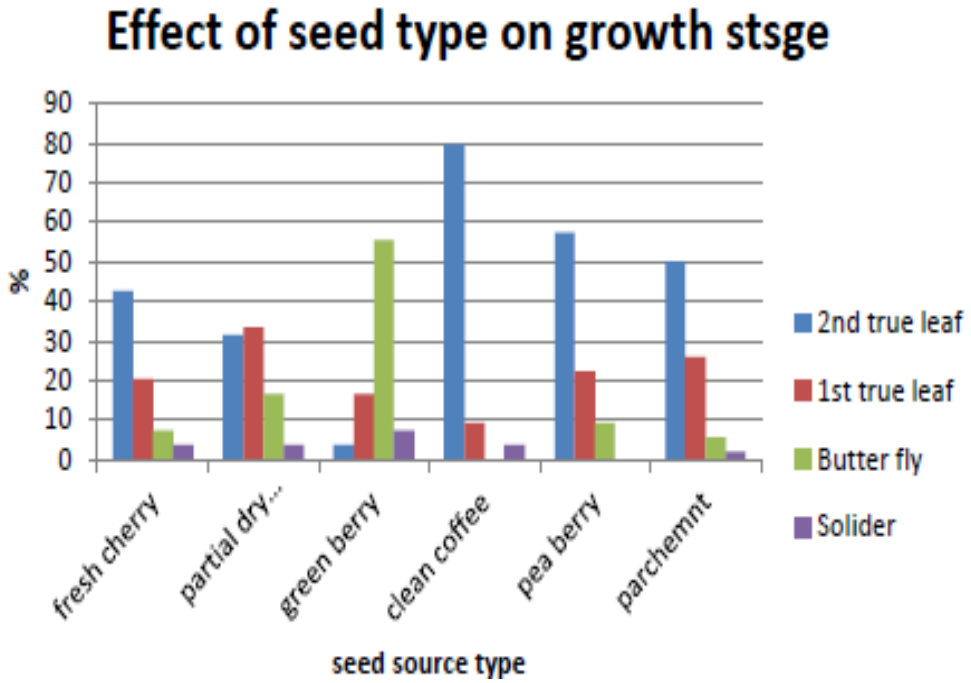

Fig2. *Effect of coffee seed source on growth stage at 135 days*

Growth Parameters

Except number of node, there was a significant difference in most of the growth parameters which include the plant height, girth, internodes length, leaf number and area. In all parameters clean coffee and pea berry perform better than the other, and the least growth recorded in all parameters in green berry (Table 2.). As far as the root growth parameters no significant difference were obtained among all seed source (Table 3.).

Table2. *Effect of seed type on the early growth of coffee seedlings*

Seed type	Growth parameters					
	Plant ht (cm)	Girth (cm)	Number of node	Inter node length (cm)	Leaf number	Leaf area (cm)
Fresh cherry	32.84b	4.61c	10.25	3.20c	9.58cd	558.07cd
Partial dry cherry	36.34ab	5.12bc	9.92	3.40bc	23.0bcd	655.43bcd
Green berry	25.52c	4.09c	9.58	2.48d	16.0d	455.95d
Clean coffee	40.25a	6.41a	10.0	4.05ab	33.83a	964.13a
Pea berry	39.33a	5.94ab	9.5	4.26a	31.67ab	902.12ab
Parchment	36.71ab	5.97ab	9.83	3.83abc	27.67abc	788.42abc
S.E	1.82	0.32	0.49	0.21	3.11	8.91
C.V (%)	8.97	10.29	8.74	10.29	21.37	21.37

Means followed by same letter(s) are not significantly different at P≤ 0.05 probability level

Destructive Parameters

Like Taye and Alemseged (2007) works, clean coffee seed was performed better than the parchment coffee in all destructive parameters recorded.

Similar result was found on leaf, shoot and root destructive parameters, where clean coffee stood first in all parameters and followed by pea berry and parchment resulted significantly higher than the other seed source as the growth parameters.

The least dry matter production was obtained in all parameters from the seed source of fresh cherry and green berry.

Though, there is a significant difference in seed source, clean coffee, pea berry, parchment and partial dry cherry didn't showed significance difference as compare to others seed source (Table 3).

The tap root length and no of lateral showed no significant difference in all cases.

Table3. *Destructive parameters of coffee seedlings as influenced by different seed growth stage and preparation*

Seed type	Destructive parameter			Total dry matter (g)	Root growth	
	Dry wt. (g)				Tap root length (cm)	No. of lateral
	Shoot	Leaf	Root			
Fresh cherry	1.52bc	1.77b	1.70ab	4.99b	23.60	20.25
Partial dry cherry	2.78 b	2.29ab	1.19b	6.25ab	21.64	23.67
Green berry	1.28 c	1.66b	1.28b	4.21b	20.52	21.83
Clean coffee	4.12a	4.88a	2.97a	11.97a	30.33	25.92
Pea berry	3.65a	4.37ab	2.55a	10.57ab	20.58	23.67
Parchment	3.11ab	3.78ab	2.60a	9.49ab	21.38	25.33
S.E	0.88	0.86	0.37	1.98	2.19	2.31
C.V (%)	55.72	47.73	31.63	43.49	16.52	17.10

Varietal Difference in Coffee Pea Berry

The study conducted on the pea berry occurrence in different selection and hybrid coffee seeds showed; there is a varietal difference in pea berry seeds bearing proportion among all coffee varieties and canopy classes i.e. compact type, intermediate, open and hybrid. The higher the pea berry proportion was found from hybrid coffee variety which is about 16% and the compact class is 7.53%, intermediate 7.16%, open types 9.22% and the high land coffee varieties 5.35%. The overall mean pea berry proportion in all pure lines classes is 7.31%. The proportion of pea berries could also vary between varieties depending on the level of tolerance of the variety to environmental stresses or environmental condition.

The hybrid seed gave 16% of pea berry which is the highest and two fold of than the selection, this is because of in hybrid coffee there is insufficient pollination due to failure of the agents of pollination (e.g. insect, wind), and incompatibility of the two parents during pollination and the less or imperfect fertilization during field crossing or hand pollination and incompatibility of the two parents during pollination.

Table4. *Ethiopian coffee varieties and mean proportion of pea berries over two cropping seasons at Jimma*

Pure line coffee varieties								**Hybrid coffee variety**	
Compact canopy class	**Pea berry %**	**Inter mediate canopy class**	**Pea berry %**	**Open canopy class**	**Pea berry %**	**High land coffee**	**Pea berry %**	**Hybrid coffee**	**Pea berry %**
74110	10.15	7487	6.85	741	6.34	Yachi	8.88	Gawe	16.22
74112	6.43	Meoftu	9.46	754	9.31	Wush Wush	3.24		
74140	5.32	Dessu	5.18	75227	10.17	BunoWoshi	3.50		
74158	7.10	**Mean**	7.16	744	11.07	MerdaCheriko	5.76		
74165	8.67			**Mean**	9.22	**Mean**	5.35		
Mean	7.53								

Pea berries seed source seedlings have ability to flower and give yield like the normal beans coffee plant. The yield obtained from the pea berry seed source plantation was range from 831.4kg/ha, 947.7kg/ha and 1500kg/ ha clean coffee for three successive cropping season.

Unlike the works of Melkam *et al*, (2014) pea berries in this study are considered aspure, because of the seed can germinate, emerge, grow and followed by giving flower and good crop. Therefore, it is genetically pure seed.

Pea berry may not be predominantly a heritable character, because seeds produced from coffee trees raised from pea berries will not develop all in to pea berries in this study. Like under normal condition, some seeds may turn in to pea berries because of that may cause flower abortion and insufficient pollination due to failure of the agents of pollination. Since the embryo development is unaffected, pea berries can germinate and produce seedlings as of the normal seed.

In addition, as indicated in all growth, non destructive and destructive parameter and the bearing potential of the pea berry seed is perform as good as the normal seed at nursery and field level.

Since the inception of distribution of coffee seeds from the Ethiopian national coffee research center, the Jimma agricultural research center distributed 789230kg different types of coffee variety seeds throughout the coffee growing regions of Ethiopia. In addition from the above amount of seeds 7% pea berries seeds are sort out from the distributed coffee seeds.

SUMMARY AND CONCLUSION

Pea berry beans are not ‘’male’’ and genetically it is pure seed. Pea berries can germinate in the same way as normal beans and produce normal seedlings to be used in modern coffee plantation. The pea berries seedlings can grow as normal coffee tree plant in the field and the trees can flower and bear potential crop. Seeds produced from coffee trees raised from pea berries will not develop all in to pea berries. Any developer can use it as a pure and healthy seed for raising seedlings and transplant at the field. Therefore, it is important to remind not to exclude or sort out during seed preparation. In general, this research highlights strongly the potential to use pea berry seed as a seed source mainly for hybrid coffee varieties use of clean seeds prepared from known coffee varieties and strengthen coffee seed science and technology at the national level.

REFERENCES

[1] **Alvim PT (1973)**. Factors affecting flowering of coffee. In: SRB, A.M. (ed), Genes, enzymes and population, pp.193-202. Plenum Press, New York.

[2] **JARC(2017)**. Jimma Agricultural Research Center Profile for the Period 2016/17. JARC, July 2017, Jimma, 27p.

[3] **JARC (2015)**. Jimma Agricultural Research Center Profile for the Period 20164/15. JARC, July 2015, Jimma, 24p.

[4] **Kenneth Davids (2003).** Home Coffee Roasting: Romance & Revival, Rev. updated ed., 76.

[5] **Melkam Anteneh, AbebeAtilaw and Taye Kufa (2014)**. Investigation of coffee seed physical purity, seed health and effect of storage time on viability. Malaysian Journal of Medical and Biological Research, Volume 1, No 2 (2014), pp 86-96.

[6] **Paulose Dubale (2008).** Retrospect and prospect of coffee research in Ethiopia. Proceedings on Four Decades of Coffee Research and Development in Ethiopia, A National Workshop, 14-17 August 2007, *Ghion* Hotel, Addis Ababa, Ethiopia, pp: 6-10.

[7] **Srinivasan, C. S. and S. Vishveshwara. 1980.** Selection in coffee: Some criteria adopted and results obtained in India. J. Coffee Res. 10: 53-62.

[8] **Taye Kufa, Ashenafi Ayano, Alemseged Yilma, Teshome Kumela, Wondyifraw Tefera (2011)**. The contribution of coffee research for coffee seed development in Ethiopia. *E3 Journal of Agricultural Research for Development*, 1(1): 009- 016.

[9] **Taye Kufa and Alemsged Yilma (2007)**. Emergence and growth of Arabica coffee seedlings as influenced by pre-sowing seed treatment. pp. 1188-1195. Proceedings of the 21st International Conference on Coffee Science Colloquium, 11-15 September 2006, Montpellier, France.

[10] **Tesfaye, S., Alemseged, Y., Taye, K., Endale, T., and Anteneh, N. (2006).** Coffee seedling management and production. Ethiopian Agricultural Research Organization, Addis Ababa, Ethiopia, 17 p. Manual in local language.

[11] **Wintgens, J.N. (2004).** Coffee growing, processing, sustainable production.A guide for growers, traders, and researchers. WILLEY-VCH verlaggmbh and co. k GaA, weinheim.

[12] **Wormer TM (1964)**. The growth of the coffee berry. Ann. Bot. 28:47-55.