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REVIEW ARTICLE

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Sesame (*Sesamum indicum* L.): Existing Status, Features, Significance and new Approaches for Improvement in the Case of Ethiopia: A Review

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ABSTRACT

Sesame (Sesamum indicum L.) is widely spread in several countries of the world and it is known as a multi-purpose plant. In Ethiopia sesame is considered as one of the main cash crops next to coffee. In spite of the economic importance of sesame for the Ethiopian economy there is big fluctuation in both production and yield. The aim of this paper is to review the existing status, features, significance and new approaches for improvement of Sesame (Sesamum indicum L.) in the case of Ethiopia. Integration of marker assisted selection (MAS) into conventional breeding programs, plant tissue culture, and induced mutation will be an optimistic strategy for sesame improvement due to the high demand for raw material to agro-processing industries and to generate hard currency. Conventional plant breeding in sesame are marred with several limitations such as access to a limited gene pool, crossing barriers, inefficient selection and being time consuming. Plant tissue culture has been extensively employed for crop improvement in Sesame but not well done in the genotypes which are cultivating in Ethiopia. MAS can be used to detect the presence of allelic variation in the genes underlying the important traits such as shattering, disease and insect resistance traits. In addition, wide array use of induced mutation and development of double haploids (DH) may play a pivotal role in sesame improvement.

The use of mutation techniques (chemical, biological and/or physical mutagens) could be a vital option in genetic improvement of locally well adapted sesame varieties.
Keyword: Marker assisted selection, mutation, sesame, and tissue culture.

INTRODUCTION

Sesame (*Sesamu indicum* L.), Pedaliaceae, the queen of oil seed crop, is one of the oldest oil crops and thought to have originated in Africa (Ram et al1990). It is widely grown in tropical and subtropical regions and adapted too marginal and sub marginal areas (Ashri, 1998). Despite the ongoing dispute (discussions) on its origin Ethiopia would seem most likely to be the center of origin of sesame (Vavilov, 1951; Purseglove, 1968).

Potentially beneficial effects of sesame on human health have recently renewed the interest in this ancient crop. Despite the nutritional value, historic and cultural importance of sesame, the research on sesame has been scarce (Laurentin and Karlovsky, 2006). Sesame has long been regarded in the orient as a health food for energy increasing and aging prevention (Hajimahmoodi et al2008). Sesame seeds are an important source of oil (44-58%), protein (18-25%), and carbohydrates (13.5%) (Bedigian et al 1985), and are traditionally consumed directly. They are used as active ingredients in antiseptics, bactericides, viricides, disinfectants, mothrepellants, and antitubercular agents because they contain natural antioxidants such as sesamin and sesamolin (Fukuda et al1986). Among the primary edible oils, sesame oil has the highest antioxidant content (Cheung et al2007) and contains abundant fatty acids such as oleic acid (43%), linoleic acid (35%), palmitic acid (11%), and stearic acid (7%) (Bedigian et al1985).

As a main component of the Growth and Transformation Plan II (GTP II), Ethiopia has planned to boost the production of oil seed crops including sesame from 9.0 to 12.7 Q/h. The oilseed sector in the country is one of the fastest growing sectors, both in terms of its foreign exchange earnings and as source of income for millions of Ethiopians. In the country sesame is the main oilseed crop in terms of area coverage and production that accounted for 49% and 38%, respectively of all oilseed crops and mainly as a commercial export commodity (CSA, 2015; FAO, 2015). Sesame is the second largest source of foreign exchange earnings after coffee (FAOSTAT, 2012). The country is the second main exporter of sesame seeds in the world, after India (FAOSTAT, 2015). It is produced by small as well as large-scale farmers and it is an important export commodity and one of the top priority crops in the GTP II of the country. Besides, the crop has wider industrial potential that may be used as a row material for agro-processing industries that popping up in the country including the currently established agro-processing park in western Tigray (Beaker around Humera).

In spite of the economic importance of sesame for the Ethiopian economy big fluctuations in production and yield occurred (Abdellatef et al2010). This low yields are mainly due to absence of non-shattering cultivars suited for mechanical harvest, indeterminate growth, uneven ripening of capsules and biotic and abiotic stresses such as diseases, pests, and drought

Ethiopia has ample genetic diversity of sesame which could be utilized in sesame improvement programs. However, lack of wider adapting varieties, shattering of capsules at maturity, susceptibility to diseases and pests, non-synchronous maturity, poor stand establishment, lack of fertilizer responses, profuse branching, and low harvest index are the major constraints in sesame production and adoption (Wijnands et al2009).

Sesame improvement could benefit markedly from the employment of the innovative molecular technologies (*in vitro* propagation, MAS, Double Haploid development, and induced mutation) that offer great potential by enhancing the efficiency of selection genotypes with remarkable resistance to pest and diseases as well as complex traits, such as yield, oil quality and tolerance to abiotic stresses. Moreover, selection for mutants (genotypes developed *via* an induced mutation) or locally adapted genotypes and/or segregating populations having a determinate growth habit, closed capsules, reasonably high disease resistance should be encouraged. Therefore, the objective of this paper is to review the existing status, features, significance and new approaches for improvement of sesame (*Sesamum indicum* L.) in the case of Ethiopia

SESAME ORIGIN, BIOLOGY AND ECOLOGY

The wide genetic diversity of the crop in Africa puts it as the primary center of origin, and India as a secondary one. Africa and Indian subcontinent are proposed to be the origin of sesame (Bedigian, 1981). On the other hand, India is generally regardedas the place where it was first domesticated, and believed to have been spread to Africa, the Far East, China, and Americas along trade routes (Bedigian, 2004). Today, sesame is widely grown as an oilseed crop in China, Ethiopia, India, Japan, Korea, Sudan, Thailand, and Turkey as well as on other African countries and the Americans.

Sesame grows in many ecological regions of tropical and subtropical climate, and most kind soil types. It thrives best on well-drained soils with moderate fertility and a pH of 5.5 to 7.0. Sesame is highly drought tolerant. It can produce seeds under fairly high temperatures (Ashri, 1998). However, moisture levels before planting and flowering has great impact on seed yield. The plant requires a minimum of 300 to 400 mm of rainfall per season. But it is sensitive to wet conditions with very low salt tolerance (Carlsson et al2008).

Sesame cultivation stimulates beneficial soil microbes and reduces nematode populations, particularly root knot nematodes that attack peanuts and cotton. Cotton grown following sesame is less attacked by root-rot. Sesame is also an excellent soil builder, as a large amount of root biomass is left to decay underground after harvest. Soil become very mellow after sesame cultivation, thus require less work to prepare for the next crop in rotation (Langham et al2008).

The genus sesame consists of many species, the most cultivated one being *Sesamum indicum* L. 36 species are identified, of which 22 are found in Africa, five in Asia, seven in both Africa and Asia, one species in Crete and another in Brazil (Kobayashi et al1990). There are three cytogenetic groups of *S. indicum* L., namely; 2n = 26, 2n = 32, and 2n = 64. The 2n = 26 includes *S. indicum, S. alatum, S. capense, S. schenckii, S. malabaricum*. While 2n = 32 consists of *S. prostratum, S. laciniatum, S. angolense, and S. angustifolium;* the 2n = 64 likewise includes *S. radiatum, S. occidentale, and S. schinzianum*. The differences in chromosomal numbers across the threecyto-taxonomic groups, lead to limited cross compatibility among the species. Therefore, it proves too difficult to transfer desirable characteristics from wild relatives into cultivated species (Carlsson et al2008).

Wild relatives of crop plants have contributed many useful genes to crop species. These modern of crop varieties contain genes from their wild relatives and are essential constituent for increasing food security and maintaining the environment. Wild sesame species are reported to possess several desirable traits such as high harvest index and other yield components, determinate growth habit with uniform ripening, early maturity, photo and thermal insensitivity, high seed retention, high nutritional quality (high oil and protein, high sesamin and sesamolin contents, reduced anti-nutritional factors and oxalic acid in seeds). Gojam Azele, Bounki, Gumero, Red/Abergele, Achawte, Zenabit, Achachiyn and Ketit are among the wild relatives of sesame located mainly on Tigray region having well morphological and yield attributes (personal communication with Fiseha Baraki, 2017)(Sesame national coordinator). Wild sesame species are tolerant to many pests and diseases *i.e*. resistance to biotic and abiotic stresses (Pathak et al2014).

The flowers of sesame are typically self-pollinated, with the possibility of 5 to 50 % cross pollinated by insects. It is annual herbaceous plant growing to a height of 50 to 100 cm. it has opposite leaves, 4 to 14 cm long with entire margin, 5 cm wide at the base of the plant, narrowing to just 1 cm on the flowering stem. The flowers are white to purple, tubular, 3 to 5 cm long. Stem is covered with fine hair. Fruit are grooved capsules often containing more than 100 seeds each seeds are small and flattened; and off-white, brown, and grey or black (Ashri, 1998).

Sesame is a short-day plant with indeterminate and determinate growth habits. Most varieties are indeterminate, which is shown as a continuous production of new leaves, flowers and capsules are produced as long as the environment remains suitable (Carlsson et al2008). Growth period ranges from 70 to 150 days, depending on the varieties and the conditions of cultivation (Ashri, 1998). The average growth period last 90 to 120 days for most cultivated species in Ethiopia.

IMPORTANCEOF SESAME

Although seeds of sesame are used as ingredients in many food items, a major part of the product is processed into oil and meal (Morris, 2002). The oil is an excellent one because of its high contents of antioxidants and its fatty acid composition (Suja et al2004). The antioxidants namely sesamin, sesamol, and sesamolin make the oil very stable with a long shelf life (Chung et al2004; Suja et al2004). Oleic (C18:1) and linoleic (C18:2) acids constitute more than 80% of the total fatty acids. The high levels of unsaturated and polyunsaturated fatty acids of the oil increase its quality for human consumption (Nupur et al2010). Moreover, the high level of polyunsaturated fatty acids are claimed to reduce blood cholesterol, high blood pressure, and prevent atherosclerosis, heart diseases, and cancers (Ghafoorunissa, 1994; Hibasami et al2000; Miyahara et al 2001). *Sesamum indicum* L. seed flour has high protein content, with high levels of methionine and tryptophan, about 10 to 12% of oil, three times more calcium than milk, vitamin, magnesium and phosphorus (Morris, 2002).

Sesame oil is used as medicine or for pharmaceutical purposes (Bedigian, 2004). The oil contains vitamin E and antioxidants, such as sesaminol and sesamolinol, there is believed to promote the integrity of body tissues in the presence of oxidizing compounds (Morris, 2002). Its consumption elevates gamma-tocopherol, content in human serum. Gamma-tocopherol influence vitamin E activity thus prevents cancer and heart disease (Cooney et al2001). The oil is used to treat gum disease and toothaches, relieve anxiety or insomnia, or used in antibacterial mouthwash by Chinese and Indian in the past (Annussek, 2001; Morris, 2002).

Sesame oil has found use in several non-food applications such as feed of livestock and poultry in paints, cosmetics, solvents, soap (Bedigian, 2004), and perfumes (Morris, 2002). The antioxidant sesamin is used as a synergist for pyrethrum or rotenone insecticides as it increases the toxicity of insecticides when spayed on flies (Haller et al1942). Hasan *et al.* (2000) reported that chlorosesamone extracted from roots of sesame has antifungal

properties, thus used as fungicide. Sesame oil gives biodiesel with similar properties to mineral diesel, but with superior environmental performance (Ahmad et al2010).
The meal left after oil extraction from the seeds is an excellent feed for poultry and livestock. The problem, with sesame when used for human consumption, though is that, it contains one of the top food allergens, due to its proteins such as the albumin precursor (14 kDa 2S) several oleosins (15 and 17 kDa) (Wolff et al2003; Leduc et al2006). Therefore, food products containing sesame are now required to be labeled in several countries (Carlsson et al2008).

NUTRITIONAL, MEDICINAL AND INDUSTRIAL USES OF SESAME

Sesame seed contains high amounts of (83% - 90%) unsaturated fatty acids, mainly linoleic acid (37% - 47%), oleic acid (35% - 43%), palmitic (9% - 11%) and stearic acid (5%-10%) with trace amount of linolenic acid (Kamal- Eldin *et al* 1992). The high levels of unsaturated fatty acids (UFA) and polyunsaturated fatty acids (PUFAs) of sesame oil enhance the quality of the oil for human consumption and plays an important role in preventing atherosclerosis, heart diseases and cancers (Miyahara *et al* 2001). Carbohydrates in sesame seed are composed of 3.2% glucose, 2.6% fructose and 0.2% sucrose along with dietary fibers. Sesame seeds are excellent source minerals like copper, calcium, phosphorous, iron, magnesium, manganese, zinc and vitamin B1. Sesame lignans have health promoting activities as well as antioxidant properties (Nakai et al2003). Sesame seeds contain two unique compounds, *viz* sesamin and sesamolin, which prevent high blood pressure and increase vitamin E supplies in animals (Kamal-Eldin et al1995). Sesame oil contains sesaminol and sesamolinol that promotes the integrity of body tissues in the presence of oxidizing compounds (Morris, 2002).
Sesame oil has been reported as a source for biodiesel and found to give a product with fuel properties (Ahmad et al2010). Hasan et al(2000) extracted chlorosesamone from roots of sesame and found it possess antifungal properties. Sesame flowers have been used to prepare perfumes in Africa (Morris, 2002). The antioxidant sesamin is used as a synergist for pyrethrum or rotenone insecticides and increases the toxicity of insecticides when sprayed against flies (Haller et al 1942).

CONVENTIONAL BREEDING

Many research center has been involved for Sesame improvement work and has been initiated by Werer Agricultural Research Centre of Ethiopia since long time ago while other Ethiopian Agricultural Research Center such as Bako Agricultural Research Centre, Humera Agricultural Research Center and Mekelle University are recently started the improvement aspects of varieties for higher productivity with tolerant to the major foliar diseases (OARI, 2006: Personal communication with Fiseha Baraki, 2016 (Sesame national coordinator); Hagos et al 2017; Micheale et al 2017 unpublished). It has been shown that different 28 improved varieties were released at different times for production (table, 1). The first variety, Kelafo-74, was registered in 1976 (MARD, 2008; HuARC, 2017). The improvement aspect was targeted to the higher seed yield and oil content and no work has been done regarding the oil quality content which is determined by the fatty acid compositions of the total oil.
Initiating breeding program that targets the overall improvement of the sesame crop particularly the major production constraints such as shattering (capsule dehiscence) would be crucial. Thus, integrating the conventional breeding approach with advanced

biotechnology tools may overcome the major production constraints and results in apparent enhanced production.

Table 1. Released sesame varieties by different research centers in Ethiopia namely, HuARC (Humera Agricultural Research Center), TARI (Tigray Agricultural Research Institute), GARC (Gondar Agricultural Research Center), SoRPARI (Somali Region Pastoral & Agropastoral Research Institute), GoPARC (Gode Pastoral & Agro-pastoral Research Center), BARC (Bako Agricultural Research Center), OARI (Oromiya Agriculture Research Institute), ARARI (Amhara Region Agricultural Research Instituter), SARC (Sirinka Agricultural Research Center), EIAR (Ethiopian Institute of Agricultural Research), WARC (Werer Agricultural Research Center) (HuARC, 2017).

S. No	Variety	Year of Release	Breeder /Maintainer	Origin	Seed yield (Quintals/ha)		Oil Content (%)	Days to Mature	Color
					Irrigated	rain			
26	Setit-2	2016	HuARC/ TARI	Ethiopia		11	53.77	80-87	White
25	Gonder-1	2016	GARC/ARARI	Ethiopia					White
24	Baha-zeyit	2016	Haremaya Univ	Ethiopia		13	56		White
23	Baha-necho	2016	Haremaya Univ	Ethiopia		12	52		White
22	Benishangul-1	2016	Assosa ARC/ EIAR	Ethiopia		7		90-115	White
21	Dangure	2015	Pawea ARC	Ethiopia		7.5	56.7		White
20	ACC 00047	2013	Srinka ARC		7-8		50.4	105-120	white
19	Chalsa	2013	Bako ARC		10.5-12			95-120	Light white
18	Setit -1	2011	HuARC/ TARI	Ethiopia	20-24	7-10	52	80-90	white
17	Humera- 1	2011	HuARC/ TARI	Ethiopia		8-10	54	90-100	white
16	Barsan	2010	GoPARC / SoRPARI		7-8		46-47	80-90	Brown
15	Lidan	2010	GoPARC / SoRPARI		7-8		45-46	80-90	Brown
14	Obsa	2010	BARC/ OARI			8-10	52-54	130-150	Light white
13	Dicho	2010	BARC/ OARI			8-10	50-52	120-140	white
12	Borkin	2007	SARC/			6-8	47-48	105-120	Brown

			ARARI						
11	Ahadu	2007	SARC/ ARARI			7-8	49-51	105-115	Brown
10	Tate	1989	WARC/ EIAR			7-9	48	110-120	Grey
9	Serkamo	1993	WARC/ EIAR	Ethiopia /Congo	15-18		44-48	95-105	white
8	Argene	1993	WARC/ EIAR	Cross	15-18		43-46	95-105	Grey
7	Adi	1993	WARC/ EIAR	Isreal	16-22		42-48	85-95	white
6	Abasena	1990	WARC/ EIAR	Ethiopia	12-19	5-12	43-48	110-120	white
5	Mehado-80	1989	WARC/ EIAR	Ethiopia	16-20	4-8	45-46	110-120	white
4	S	1978	WARC/ EIAR	Uganda	12-16	4-12	43-47	110-120	Grey
3	E	1978	WARC/ EIAR	Uganda	12-16	4-12	45-48	110-120	Grey
2	t-85	1976	WARC/ EIAR	India	9-20	5-7	43-48	100-115	white
1	Kelafo	1976	WARC/ EIAR	Ethiopia	10-20	3-6	44-47	110-120	Black

Given the context of current yield limiting factors under the unpredictable climate scenario, biotic as well as abiotic stresses, traits related to yield stability (in agronomic sense) and sustainability should be a major focus of sesame improvement efforts. Traits that include shattering resistance, durable leaf disease and webworm resistance as well as nutrient use efficiency should also be of prime target. To solve the problems related with specific traits. Ethiopian Institute of Agricultural Research (EIAR) is currently engaged in the research of Sesame seed for cultivation. This institution has many research centers located in different corners of the country that are conducting various studies in order to adopt seed varieties that are able to increase productivity with minimal environmental degradation via convectional breeding strategy. This system can satisfy the high demand of the country and this needs modern biotechnology to solve the problems of conventional breeding. A full account of the different types of Sesame Seed Varieties that have developed by different research centers are summarized by the table below.

NEW APPROACHES FOR SESAME IMPROVEMENT

Sesame Tissue Culture

Several opportunities now exist for sesame improvement as a result of recent developments in plant tissue culture and generic manipulation of crop plants. Sesame plants can be regenerated from shoot apical meristems and hypocotyl segments and grown to maturity in less than four months. Similar reports of successful plant regeneration from hypocotyl segments have been published (George et al1987). This provides an opportunity for generic transformation using *Agrobacterium* as a vector.

Tissue culture methods can also be used to facilitate wide crosses using embryo culture techniques. Although conventional hybrid crosses between cultivated sesame and its wild relatives have been attempted (Nayar and Mehra, 1970), in most cases hybrids were difficult to produce. In preliminary studies, we cultured zygotic embryos at various developmental stages, and plants were regenerated from embryos obtained 15 days after pollination. Similar methods could be used to regenerate plants from embryos generated from wide hybrid crosses. Tissue culture methods involving a callus phase or regeneration via somatic embryogenesis are known to produce stable variants (Armstrong and Phillips, 1988).

The potential benefits of using advanced agricultural biotechnology in sesame genetic improvement have not yet been realized in Ethiopia mainly because the successful utilization of plant biotechnology for plant improvement requires the development of an efficient shoot regeneration system from cultured cells or tissues. The development of an efficient micropropagation protocol can highly support breeding of this potential and adaptive oil crop. Moreover, the establishment of cell culture has considerable potential to facilitate successful wide crosses using embryo culture techniques. In different part of the world more research works have been conducting in sesame. These research works have target on adventitious shoot regeneration from shoot tip (Rao and Vaidyanath, 1997), nodal (Gangopadhyay et al1998) and leaf (Sharma and Pareek, 1998) cultures. Hypocotyl and/or cotyledon explants (Rao and Vaidyanath, 1998; Taskin and Turgut, 1997; Younghee, 2001) has been reported but at low frequencies. In Ethiopia very little research works are conducting in sesame tissue culture mainly in Mekelle University. The present communication describes *in vitro* multiple shoot regeneration from shoot tip explants, seed and the rooting and successful greenhouse establishment of some selected Ethiopian sesame cultivars. Sesame in general, has proved to be very recalcitrant to regenerate *in vitro* (Were et al2006). This technology will facilitate the biotechnological research work in the future since this crop is Ethiopia's future crop due to more expansion of agro-processing plants and high export demands. Therefore, there is an urgent need for developing an efficient *in vitro* regeneration protocol involving Ethiopian sesame cultivars with regard to multiple shoots induction and production of most common agronomic traits. Efforts have already started in biotechnology related research centers and universities but more work is recommended to produce better yield by producing varieties which can capable of tolerating both biotic and abiotic stresses via tissue culture.

I*n vitro* regeneration potentiality of four Ethiopian sesame varieties (Hirhir, Humera-1, setit-1 and Nonshatter) have been observed and an efficient as well as reproducible protocol for regeneration of the genotypes have been developed using anther as explants. This is used to develop double haploid and release as varieties (Yifter et al2013). To date, fourteen sesame genotypes have been conducting the seed, shoot tip and mutated seed regeneration to observe their differences and similarities. Their progeny will be screened for variation in characteristics such as seedling growth, vigor, placental thickness, capsule dehiscence, seed size, seed dormancy, yield, oil content and oil quality. Callus cultures derived from cotyledons and hypocotyl segments will be induced to produce embryos. Long-term callus culture systems would be useful for *in vitro*selection studies involving selective agents such as pathogenic fungal toxins, herbicides, and minerals.

Marker Assisted Selection

New technologies such as biotechnology will be needed to complement with the conventional approach that may maximized yield. One area of biotechnology, DNA marker technology, may offer prodigious promise in sesame improvement. Molecular markers are neutral sites of variation at the DNA sequence or protein level. Molecular markers are classified into two types: biochemical and DNA markers. These markers determine polymorphism between plant accessions or species for breeding, mapping or genetic variation surveys. DNA markers show polymorphism at the DNA level. There are Restriction Fragment Length Polymorphism (RFLP), Random Amplified Polymorhic DNA (RAPD), Simple Sequence Repeats (SSR) or Microsatellites, Expressed Sequenced Taqs (ESTs), Amplified Fragment Length Polymorphism (AFLP), Sequence Related Amplified Polymorphism (SRAP), Cleaved Amplified Polymorphic Sequences (CAPS), and Single Nucleotide Polymorphism (SNPs). Owing to genetic linkage (both linkage equilibrium and non-equilibrium), DNA markers can be used to detect the presence of allelic variation in the genes underlying the important traits such as shattering, disease and insect resistance traits. Therefore, integration of marker assisted selection (MAS) into conventional breeding programs will be an optimistic strategy for sesame improvement due to the high demand for raw material to agro-processing industries and to generate hard currency.

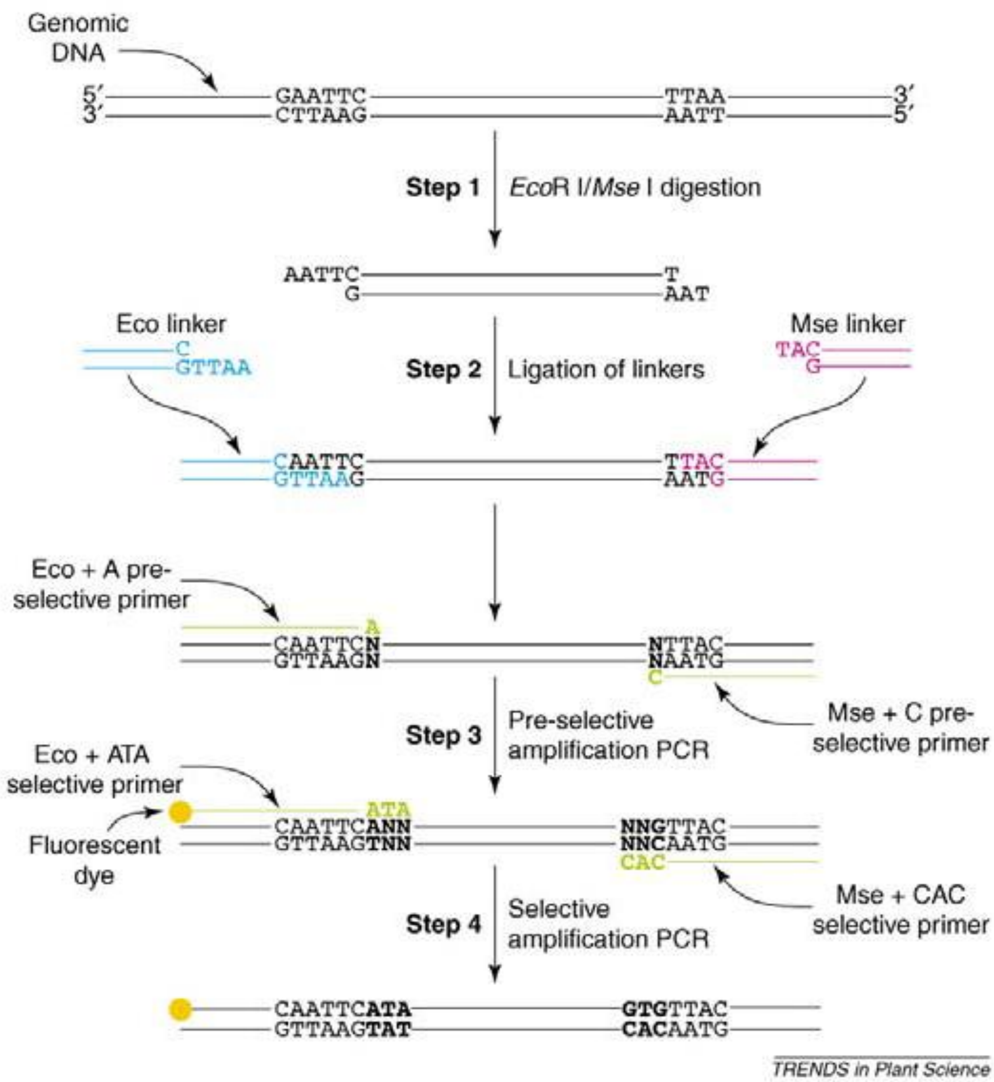

Figure 1. Basic steps of Amplified Fragment Length Polymorphism (AFLP): (Meudt et al 2007)

Induced Mutation

In addition to the marker assisted selection (MAS), wide array use of induced mutation and development of double haploids (DH) may play a pivotal role in sesame improvement. The use of mutation techniques (chemical and/or physical mutagens) could be a vital option in genetic improvement of locally well adapted sesame varieties. Well adapted and available local varieties (e.g. Hirhir) requiring improvement in one or two characters (particularly shattering and disease resistance attributes) may be used in breeding programs using induced mutations. The deployment of induced mutation has proved very successful in persuading agronomically desirable traits such as increased seed yield, earliness, modified plant architecture, disease resistance, seed retention, and high oil content (Van Zanten, 2001).

Sodium azide (NaN_3) is the least dangerous and the most efficient mutagen and has been reported to be mutagenic in several crop species (Mostafa, 2011). The mutagenicity of sodium azide is arbitrated through the formation of an organic metabolite which enters the nucleus, interacts with DNA, and generates point mutations in the genome. Many researchers have reported the adverse effects of physical and chemical mutagens on various biological parameters (Lal et al 2009; Dhakshanamoorthy et al 2010; Sangle et al 2011). In addition, there are other chemicals which are important for the improvement of sesame. These are ethyl methane sulfonate (EMS), methyl methane sulfonate (MMS). Physical mutagens (electromagnetic radiation (ultraviolet, X-rays, and gamma rays) and Biological mutagens are also plays a critical role for sesame improvement.

CONCLUSION

Sesame seeds with high amounts of nutritional components are consumed as a traditional health food for its specific antihypertensive effect, anticarcinogenic, anti-inflammatory and antioxidative activity. Besides food, sesame also finds its uses in application areas such as pharmaceutics, industrial, and as biofuel. The seeds have about 25% protein with antioxidant lignans such as sesamolin, sesamin and have been used as active ingredients in antiseptics, bactericides, vermicides, disinfectants, moth repellants, anti-tubercular agents and are considerable source of calcium, tryptophan, methionine and many minerals (Bedigian et al 1985). A study also showed that sesame oil lowers the cholesterol level and hypertension in human beings (Lemcke-Norojärvi et al 2001) and it reduces the incidence of cancer (Hiroshigehibasami and Nishibe2000).Interestingly, Ethiopia's second export commodity next to coffee is Sesame. Despite these advantages of Sesame, thereare many challenges reducing the production and productivity. For example, Sesame is unimproved and variety of collections have been generated of land races, with little genetic information that can make the breeding programs challenging. A number of factors affecting sesame improvement programs have been identified. Firstly, the germplasm of sesame is not as large as in other crops (Ashri 1982). Secondly, the genetic architecture of sesame is poorly adapted to mechanized farming system due to its indeterminate growth habit, sensitivity to wilting under intensive management and seed shattering at maturity (Uzun and Çağırgan 2006). Thirdly, the diseases and pests are reducing the production and productivity tremendously. There is also less attention given by the government and scientists.

Therefore, integrating the conventional breeding approaches with advanced biotechnology tools may overcome the major production constraints and results in apparent enhanced production. For instance, an integrated approach combining sesame tissue culture, marker assisted selection and induced mutation needs to be undertaken using all available technological advancements. The potential benefits of using advanced agricultural biotechnology in sesame genetic improvement have not yet been realized in Ethiopia mainly because of the biosafety framework, willingness of the government, lack of skilled manpower and lack of facilities.Thus, integration of marker assisted selection (MAS) into conventional breeding programs will be an optimistic strategy for sesame improvement due to the high demand for raw material to agro-processing industries andgenerate hard currency. In addition to MAS, wide array use of induced mutation and development of double haploids (DH) may play a pivotal role in sesame improvement. Moreover, the continuous utilization of mutation breeding usingchemical and/or physical mutagenscould be a vital option in genetic improvement of locally well adapted sesame varieties.

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