Chapter

Seed Biology and Phytochemistry for Sustainable Future

Nikhat Farhana, Ripudaman M. Singh, Mohammed Gulzar Ahmed, Thouheed Ansari, Abdul Rahamanulla, Ayesha Sultana, Treesa P. Varghese, Ashwini Somayaji and Abdullah Khan

Abstract

The ranking of seeds represents remarkable transition phase for photosynthasis and sexual reproduction, this phase is complex & successful method for sexual reproduction in vascular plants. As we know that seed containe the genetic repository of past & potential for its perpetuation in the future. The dormancy in seeds induced by desciccation & the hormone abscisic acid (ABA) till the condition in growth become favorable. The well developed seeds eliminates requirement of water during sexual reproduction & allows fertilization events to occur over long distances. Germination of seeds in particular situation and season is determines the interaction between dormancy and relating factors like phytochemical development to give healthy bioactives, which strongly influence on the termination of dormancy or initiatin of germination and seedling in many plant species like photo-hormons, light, temperature, water, neutrients and mechanical cuse. Seeds of particular plants needs difreent pretreatment to give vigor seedlings even in production so far. The entiteled chapter represents amulgumation of agriculturists and life scientists. Recent significant progress has been endorsed in seed physiology to solve the practical issues constantly associated with the seeds. The aim & objective of this articale is to enlighten the reader, not only about the different aspects of the seed physiology it also includes the development of bioactive (secondary metabolites) in the healthy seeds. This resorce of pice will help researcher to sencitize about the type of healthy bioactive available in the shalls of seedlings. This could be the reason to isolate the biomolecules from a well evaluate seeds, seed evalution not only the sorce to get healthy crops in agricultural scince it also helps so for a phytochemist to get theuraputicaly active biomolecules, without destroying the nature, which could be the value added thought to combat with the burning issues associated with the existing situation (COVID Omicron, viral infection and all kinds of disorder associated with the immune system). Henceforth, endorsed personage to give real-time attention to plant propagation, particularly for indigenous tree species and seedling multiplication should be regarded as a primary need to make not only a sustainable environment but also become a treasure to fulfill the needs of industry application in the field of agriculture plus R & D.

Keywords: germination, synthesis, natural molecules, phytochemistry, industry, endorsed, COVID Omicron,R & D

1. Introduction

The Life cycle of flowering plants follows distinct development milestones which start beginning from seeds to converting into plants or crops, ultimately enabling new seed production, plants are adaptive to the native environment, and in the time taken from fertilization and germination, anything can be done to increase the proportion of seeds that emerge and the rate at which they do so, will have a large impact on farmers and researcher's livelihood, a sensitized former knows about mechanisms underlaying, development germinability, dormancy and storability to improve the performance of seeds which involves temperature, moisture, oxygen light and all other factors related to storage similarly the natural chemistry research depends on the perceptions of formers working attribute to make healthy seeds which come out with highly active primary and secondary metabolites. Seeds are considered a major source of food hence all information concerning their nutritive value, chemical composition and quality. Several hormones and chemicals are used to improve the oil, protein, and other economic attributes of seeds. Overall to say seeds are the connection between the past and future. They contain the genetic wisdom of the past and the potential for its perpetuation in future. The natural packaging of the genetic repository remarkably protects the germplasm collection. This chapter takes the reader to the world of healthy seeds with its repository of chemical composition required and enlighten the reader about the biotechnological research during the last two decade and opened up unprecedented opportunities in any area of basic and applied biological research, plant tissue culture which is important components of plant biotechnology, phytochemistry and pharmacological importance put ups the new strategy for the improvements of cereals, legumes, forest trees, crops plantation, ornamental plant. Nowadays, seed technology is a most important tool to breeders and scientists of plant tissue culture and phytochemistry, it has offered a powerful advantage for large-scale mass propagation of elite species [1].

2. Germination in the soil and standard establishment

Germination is the fundamental process by which different plant species grow from a single seed into a young plant. This process essentially influences both crops yield and quality, here the seed observes water by the passage of time, chilling, warming, oxygen availability, and light exposure may all operate while initiating the process, the rehydration will expand the cell embryo which increases the rate of respiration, and various metabolic processes suspended or much reduced during dormancy resume. These events in the life of seeds are associated with anatomical changes in cell organelles (membranous bodies concerned with metabolism), in the cell of the embryo inside the stigma, whereas each seed reacts individually to its microenvironment. A field consists of a wide range of microenvironments, how seeds establish & germinate under field conditions hence the uniformity of crops associated with seedbed preparation (perry 1973; Hadas wolf), the performance of crops' physical and chemical properties is as per the stability climatic uncertainty and traffic history. Hence germination is the preliminary stage to represent the quality of seeds (**Figure 1**) [2].

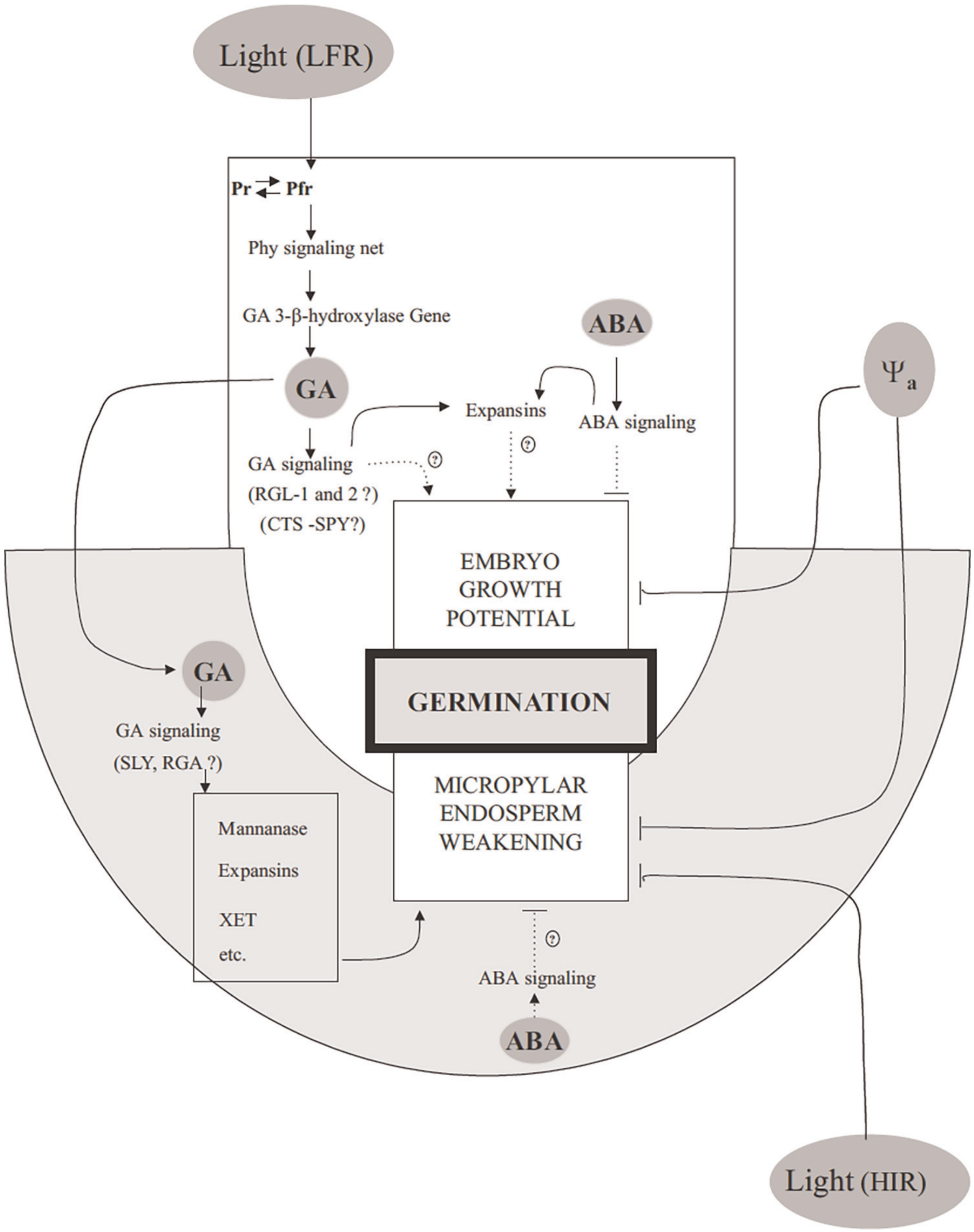

Figure 1.
Diagrammatic representation of part of the molecular signaling and components acting on the termination of coat-imposed dormancy and the induction of germination. Broken lines and question marks represent probable but unconfirmed interactions.

3. Dormancy of the crops & weeds

As discussed, the dormancy of crops & weeds goes on the season. Dormancy is the state of seeds and buds were alive but not germinating if the process takes place once the seedlings get destroyed. Dormancy allows the storage of millions of seeds in the soil and enables them to grow in flushes over the years. In this context the horticulturist saying will fit onto "One-year seeding seven-year weeding" appropriately fit onto the heading, the high persistence of seeds results from their multifaced mechanism important among these are; prolific seed production, vegetative propagation, rapid dispersal, inherent hardiness, evasiveness, self-regeneration, selective invention and weed success. Whereas weeds and seeds are dormant for three reasons i.e. enforced dormancy, innate dormancy and induced dormancy. Finally, the overall persistence of weed depends upon its capability to adopt one or more of the above-cited features. A weed species that embodied the majority of these factors is surely a horrible weed (**Figure 2**).

To conclude seed dormancy has different elaborations based on the different lookout and thinking of beings, this was a highly complicated phenomenon and weakly understood even though a huge number of publications available on this topic, as mentioned factors above the complexity are due to mechanical, physiological and biological some time it may be controlled by the environment. The known fact of dormancy not only induction and braking but complications were interrelated issues with the seed's anatomy and physiology like seed coat, embryo, cotyledon, endosperm, cell organelles, nuclei, all need much research with the role of external environment on seeds. Weeds are of most concern to farmers as well as researchers, backup data is available on this but less research relating to seed coat structure, temperature, pressure, light, hormones synthetic chemical enzymes metabolites and related chemical factors need to be explored, however seed dormancy and weed is the main issues needs in-depth research to solve the formers researchers issues related to field environment or chemical composition both are interrelated vice and versa [3].

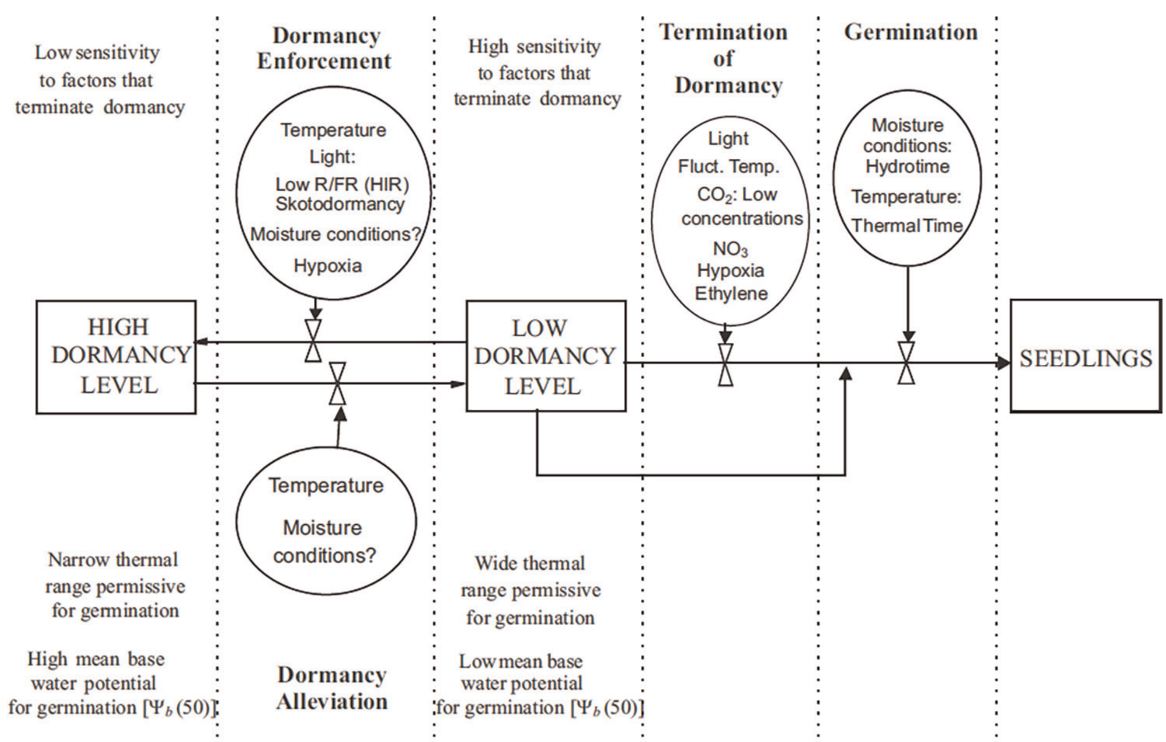

Figure 2.
Flowchart representing changes in dormancy level and termination of dormancy in seed populations and the factors that most likely affect each process (source: Reprinted from field crops research 67 [2], R. L. Benech-Arnoldet al., environmental control of dormancy in weed seed banks in soil, pp. 105–122, copyright 2000, with permission from Elsevier science).

4. Seeds longevity & storage

Seeds even if adequately protected while storage the chances are more to undergo deterioration with time, major factors affecting the longevity (life span) of mature, variable and healthy seeds are moisture, storage, temperature and pests. Seeds are of different species require different storage conditions, some seeds with the hard court can be stored at room temperature for several years (42°F to 5.6°C), the actual storage is depending upon the viability and moisture content of the seeds when initially placed in storage, the specific Variety and condition of the storage is an environment, hence keeping seeds in a glass jar with a sealed container including desiccant in the jar, whereas the germination and viability will decline with age of seeds, viability is the ability to produce a vigorous seedling. Hence viability decline before germination, so old seeds gives weak seedlings but germinate, some standard tables are given for the perusal of the readers which are mentioned in the article johnny selected seeds (**Figures 3** and **4**) **Table 1** [4].

5. The industrial quality of seeds

The seed plants mean producing another plant thereby perpetuation the species. The safe storage will reflect the quality of the seeds and the ability of the plant to provide seeds as stores of nutrients has also made them an attractive food source for human-kind, making the transition from hunter-gatherer to a settled agriculture existence and

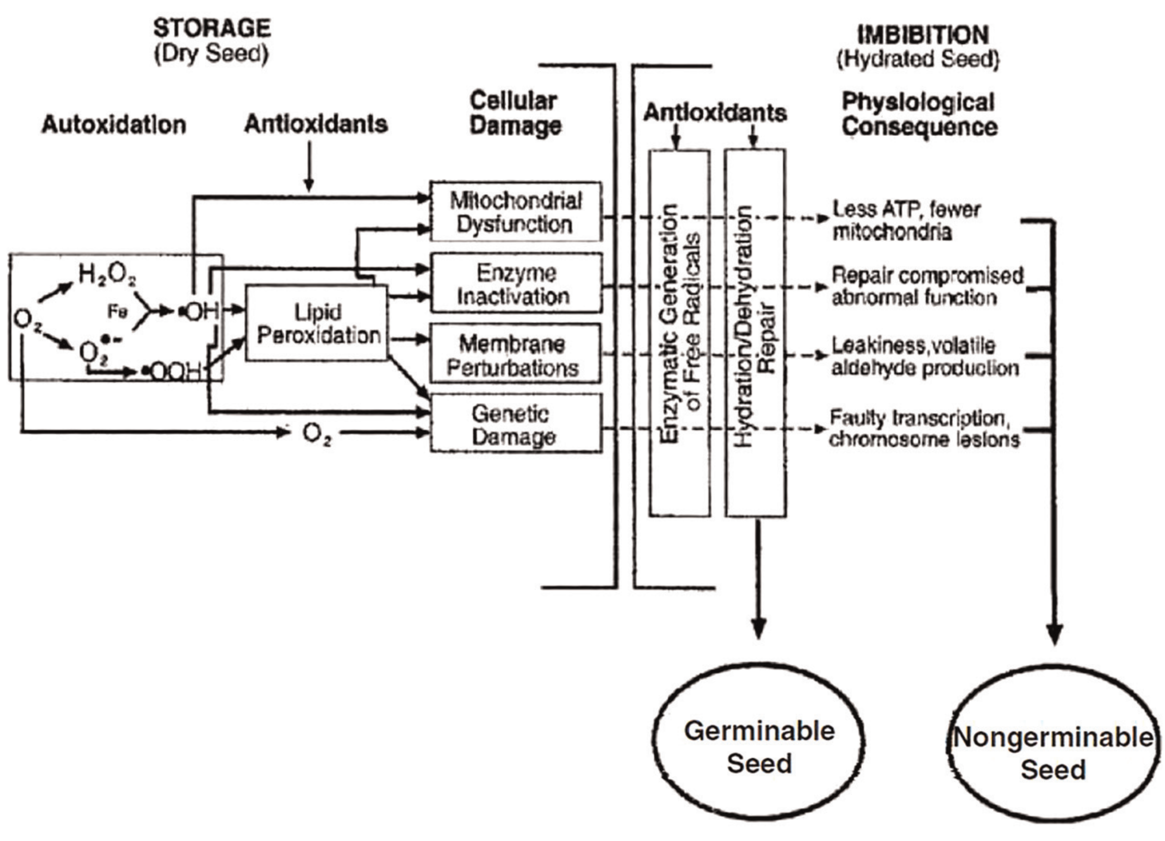

Figure 3.
A model of seed deterioration and its physiological consequences during seed storage and imbibition (source: M. B. McDonald, 1999, seed deterioration: Physiology, repair and assessment, seed science and technology 27:177–237. Reproduced with permission).

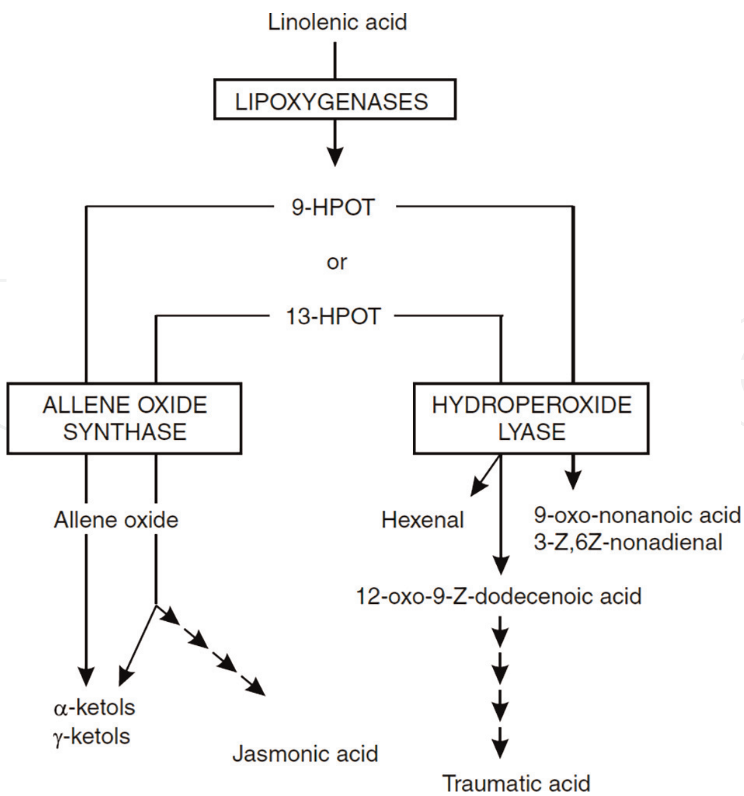

Figure 4.
Overview of the lipoxygenase pathway. 9-HPOT, 9(S)-hydroperoxytrans-10, cis-12, cis-15octadecatrienoic acid; 1-HPOT, 1(S)-hydroperoxy-cis-9, trans-11, cis-15-octadecatrienoic acid. (source: From Loiseau et al., 2001. Reprinted by permission of CABI publishing, Wallingford, Oxon, UK).

natural drug discovery process (**Table 1**) represent grain species utilized as food for man, animal and available bioactive. This development led in turn, to the building of permanent dwellings and a wide range of cultural activities. Whereas this bioactive form of dicotyledonous grains and monocotyledonous grain (cereals), will play a very important role in daily life, in some individual grains causes dietary issues, hence whole grain and fiber food inclusion will give proper nutrients vitamins and minerals because of the increased number of fibers in the diet. Whereas drugs which have food value will be more sustainable and easily binds to the target part of the cell and enzymes referee the (**Table 1**), to be concluded over here if germination to storage all the protocol followed properly and seeds and cereals are healthy and loaded with all forms of nutrients will make them become a source to get healthy bioactive out of it, to utilize as drug molecule to treat different disorders associated with the human body without involving harmful synthetic substances. The process of treatment is from "nature to creature and creature to cure with the sustainable process" [5].

6. Phytochemistry of seeds

The phytochemistry associated with the pharmacological and therapeutic effects elicited by plant material, literature survey states seeds were observed to contain appreciable amounts of alkaloids flavonoids, anthraquinone, saponin, and terpenoids and tannin (**Table 1**). As mentioned above all factors affect on the composition of chemical constituents. This chapter mainly focuses on the metabolic properties of healthy seeds and the benefits to utilize the bioactive as a drug molecules. In addition,

Family	Examples	Descriptions	Secondary metabolites
Endospermic seeds (flower and fruits)			
Cucurbitaceae Core Eudicots Rosid clade	**(Cucumis melo)**	In muskmelon seed the embryo is surrounded by a perisperm/ endosperm envelope. Callose (B-1,3-glucan deposition in this envelope is responsible for the apoplastic semi permeability of muskmelon seeds. The perisperm/endosperm envelope is weakened prior to the completion of germination	**Phenols, lipids fats carbohydrates vit. B12**
Fabaceae Core Eudicots Rosid Clade	**Fenugreek (trigonella foenum) graecumcrimson Clover (Trifolium incarnatum) Lucerne (Medicago Sativa)**	**Only some legume (Fabaceae) seeds are endospermic most legume seeds are non-endospermic**	**Phenols, lipids fats carbohydrates, fructose, cellulose**
Euphorbiaceae Core Eudicots Rosid clade	**Castor bean (Ricinus Communis)**	Castor beans seeds (Malpighiales) are a classical seed system reserve breakdown	**Phenols, lipids fats carbohydrates, galactose**
Brassicaceae Core Eudicots Rosid clade	**Garden cress (Lepidium stivum) mouse-earcress (Arabidopsis thaliana)**	Only some Brassicaceae seeds are endospermic, most Brassicaceae seeds are non-endospermic. Mature seeds have 1-2 cell layers of endosperm, while *Lepidium* of has a single endosperm cell layer. This Arabidopsis two-step germination two species exhibit, as tobacco, We. (distinct testa rupture and endosperm rupture) is a promising model system for *Lepidium* found that .(Müller et al. 2006 endosperm weakening	**Phenols, lipids fats carbohydrates**
	Cestroideae: subgroup Tobacco *Nicotiana tabacum-Nicotiana* other species petunia	Mature seeds of the Solanaceae family usually have an abundant endosperm layer. Well investigated examples **tobacco and tomato, which are model systems in are seed biology for the study of endosperm weakening and the regulation of germination by plant hormones** The Solanaceae family can .**and environmental factors** :be divided into two large subgroup	**Phenols, lipids fats carbohydrates**
Solanaceae - Core Eudicots Asterid - clade	*Petunia hybrida* **Solanoideae: subgroup** tomato *Lycopersicon esculentum* pepper *Capsicum annuum* Datura (*Datura ferox*)	**Cestroideae subgroup of Solanaceae (tobacco, :(petunia** Straight or slightly bent embryos and prismatic to **two-step germination (distinct testa,** subglobose seeds typically capsules as **(rupture and**	**Phenols, lipids fats carbohydrates, flavonoids, quercetin**

Family	Examples	Descriptions	Secondary metabolites
		endosperm rupture .fruits : (Salanoideae subgroup of Solanaceae (pepper, tomato Curved embryos and flattened, discoid seeds, no visible distinction beween testa rapture and endosperm rupture, often berries as fruits	
Rubiaceae Core - Eudicots Asterid - clade	Coffee *Coffea arabica*	The coffee embryo is enveloped by an endosperm tissue. The fully differentiated embryo lies inside an embryo cavity. The endosperm is surrounded by endocarp, which resembles a seed **Endosperm weakening of coffee is inhibited by abscisic** . coa .(and promoted by gibberellins (GA (**acid** (**ABA**	**Phenols, lipids fats carbohydrates, fats**
Oleaeceae Core - Eudicots Asterid - clade	*Syringa* species	seeds is mainly imposed *Syringa* Low temperature dormancy by the mechanical resistance of the endosperm layer	**Phenols, lipids fats carbohydrates, lipids**
Asteraceae Core - Eudicots Asterid - clade	**lettuce *Lactuca sativa***	Lettuce "seeds" are actually fruits and have 2-3 cell layers of **endosperm weakening Lettuce** . endosperm below the pericarp has been demonstrated and the hormonal regulation of lettuce seed germination is similar to tobacco	**Phenols, lipids fats carbohydrates, sugars aglycon**
Apiaceae Core Eudicots - Asterid clade -	Celery *Apium graveolens*	Seeds of Apiaceae (Umbelliferae) contain relatively large amounts of living endosperm which completely surrounds a small embryo located at the micropylar has been **Endosperm breakdown** .end of the seed demonstrated and is promoted by gibberellins	**Phenols, lipids fats carbohydrates**
Ranunculaceae Basal Eudicots -	*Trollius* species	The seeds of basal angiosperms often have underdeveloped embryos that are embedded in abundant endosperm tissue. Two-step germination process with distinct testa rupture and endosperm rupture	**Phenols, lipids fats carbohydrates**
Poaceae and other monocot families Basal - Angiosperms Monocots -	wheat *Triticum aestivum* barley *Hordeum vulgare* Maize (*Zea mays*)	A typical monocot seed with endosperm is onion Alliaceae family. In the highly (*Allium cepa*) specialized cereal grains/ caryopses (wheat, barley, maize) the endosperm can be divided in the starchy endosperm (starch	**Phenols, lipids fats carbohydrates, amino acids**

Family	Examples	Descriptions	Secondary metabolites
		grains, food storage, dead cells, flour) and the aleurone	
	Onion *Allium cepa*	layer (living cell layer surrounding the starchy endosperm). The cereal .embryos are highly specialized in their structure	
Fabaceae Core - Eudicots Rosid - clade	Pea (*Pisum sativum*) garden bean *Phaseolus vulgaris* soybean (*Glycine max*)	Most species of the legume family ***Pisum*) pea** (Fabaceae) including and diverse beans have (***sativum*** non-endospermic seeds. The serve as sole food **cotyledons** storage organs as in the case of pea .During embryo. (*Pisum sativum*) development the cotyledons absorb the food reserves from the endosperm completely. In the mature seed the embryo is enclosed solely by the testa as the only seed regulation by covering layer. The ethylene of pea seed germination has been and seedling emergence studied in detail	**Phenols, lipids fats carbohydrates, fats proteins**
Brassicaceae Core - Eudicots Rosid - clade	Rape (*Brassica napus*) wild mustard (*Sinapis alba*) wild radish *Raphanus sativus*	Most species of the mustard family (Brassicaceae) including several species have non— *Brassica* **cotyledons** endospermic seeds. The serve as sole food storage organs as described for the non-endospermic. Fabaceae seeds	**Phenols, lipids fats carbohydrates cellulose**
Seeds with perisperm			
Amaranthaceae incl.) Chenopodiaceae) - Core Eudicots Caryophyllid - clade	sugar beet (*Beta vulgaris*) lambsquarters *Chenopodium album*	is diploid maternal **Perisperm** food storage tissue that originates from the nucellus. It is present in mature seeds of many **Caryophyllales** including the ((**Centrospermae** *Beta,*) Amaranthaceae among the (*Chenopodium* eudicots, but also in basal angiosperms like black pepper Piperaceae (*Piper nigrum*)	**Glucose fructose galactose, reducing and non-reducing sugar**

Table 1.
Category of seeds with phytoconstituents belonging to different families.

healthy seeds and grains are an excellent source of macromolecule and macromolecule. It is observed from the available literature that the seeds which have food value have properties to cure different diseases and its element. Moreover, the oldest sacred book composed of an ancient forms of formulation utilized as medicine from seeds (www.britannica.com/topic/Atharvaveda) are Rigveda, Ayurveda, Quran, Bible and other religious scriptures elaborated on the medicinal properties of healthy properties of seeds,

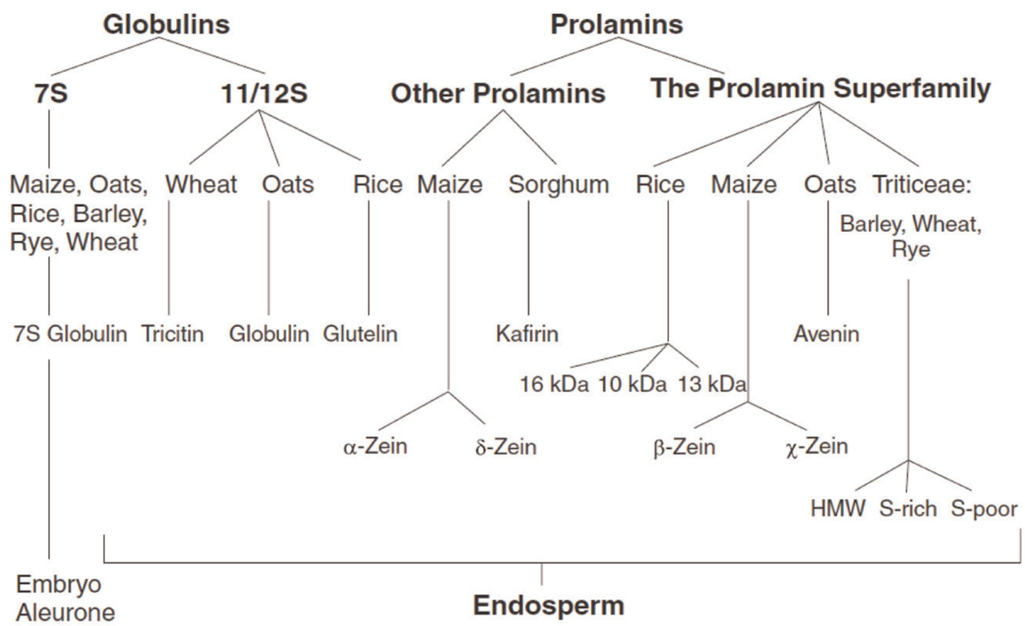

Figure 5.
Classification of the cereals, according to the types of proteins intheir grains (source: Adapted from Shewry, 1996.).

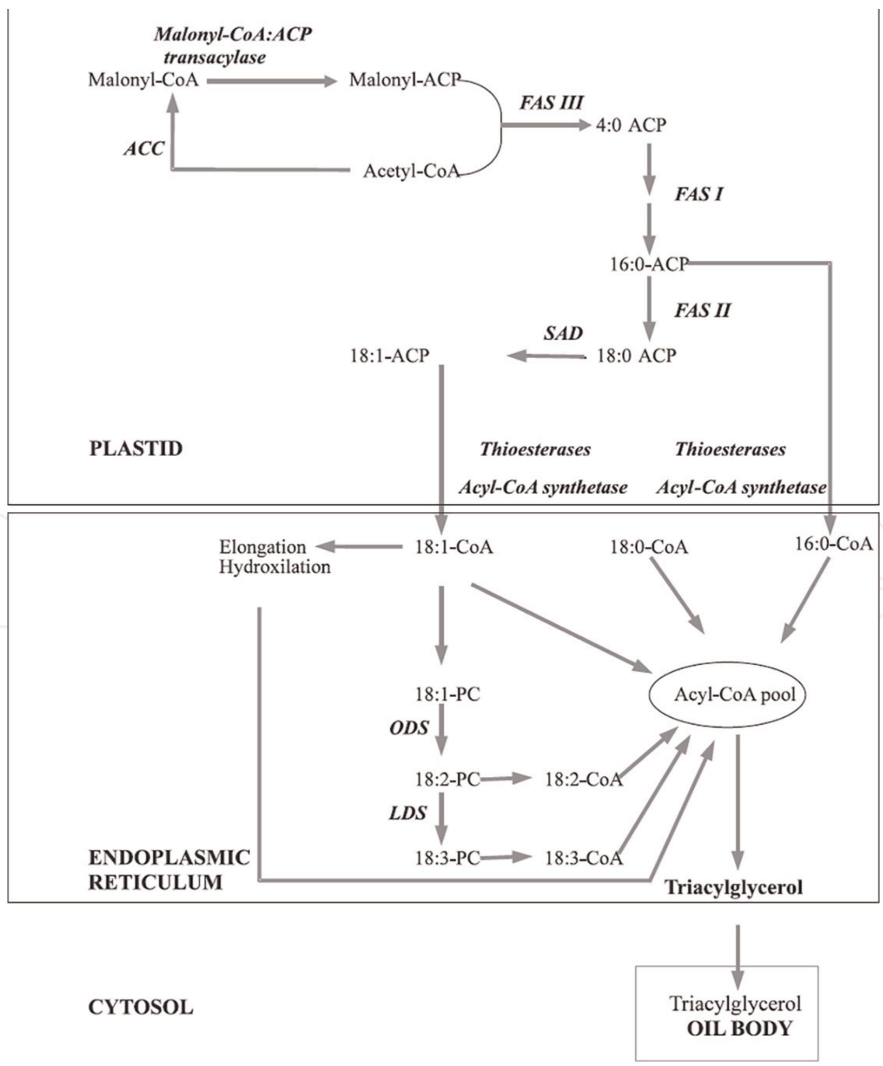

Figure 6.
Representation of triacylglycerol biosynthesis in developing seeds.

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this chapter emphasizes the consequences of secondary metabolites available in healthy seeds to utilize for the cure, mitigation of different disease, disorders and its elements.

Whereas phytochemistry tie-up with agricultural science will solve the burning issues of toddy' suncontrolled viral infection or boost the immunity as well. Some important biosynthesis is given here to focus on the metabolites from a different forms of seeds (**Figures 5** and **6**).

6.1 Stages of metabolism macromolecules

The metabolic stage will begin at an early stage of germination and results in the activity of various enzymes, which are present in the dry seeds or very rapidly become active as seeds imbibe water (**Figure 7**).

6.1.1 Carbohydrates & Lipids

Sucrose biosynthesis.

6.1.2 Sucrose hydrolysis

$$\text{Sucrose} + \text{H2O} \xrightarrow{\text{Invertase}} \text{Glucose} + \text{Fructose}$$

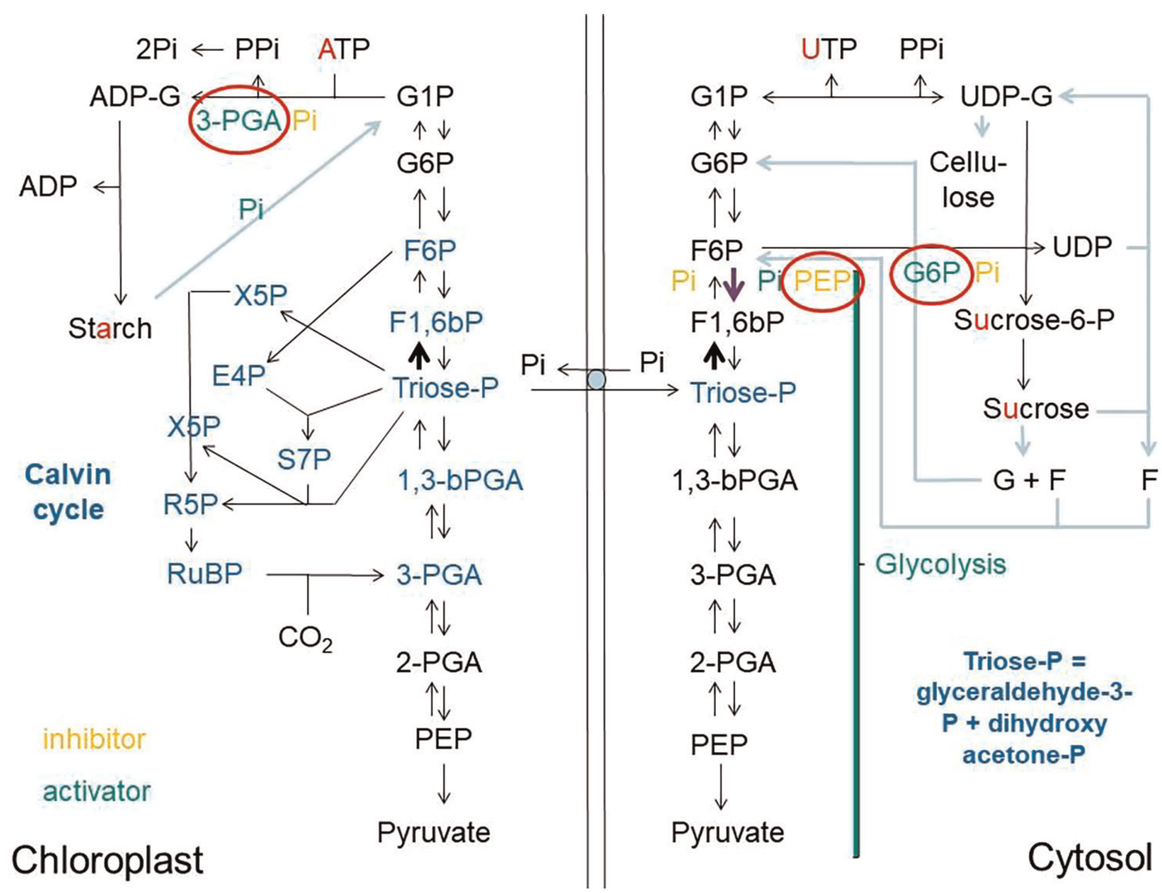

Figure 7.
*Overview of starch, sucrose and cellulose synthesis in plants and its regulatory architecture source: Google images (**Figures 8** and **9**).*

6.1.3 Protein

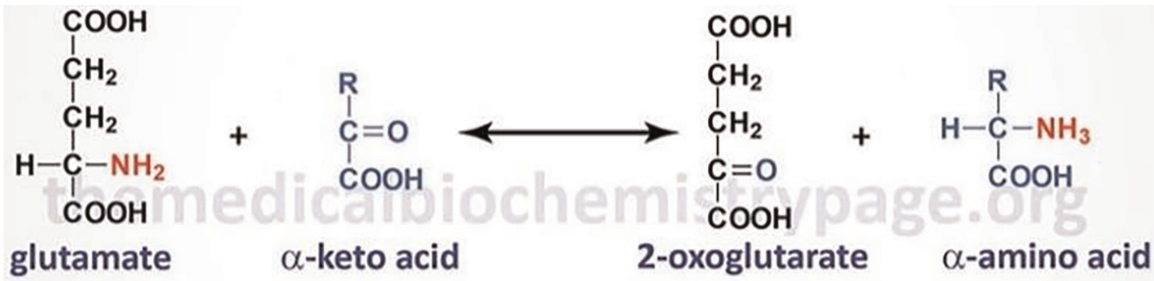

Figure 8.
(SourceRepresentative reaction catalyzed by an aminotransferase (transaminase). 2-Oxoglutarate is commonly called α-ketoglutarate. Source: Google images.

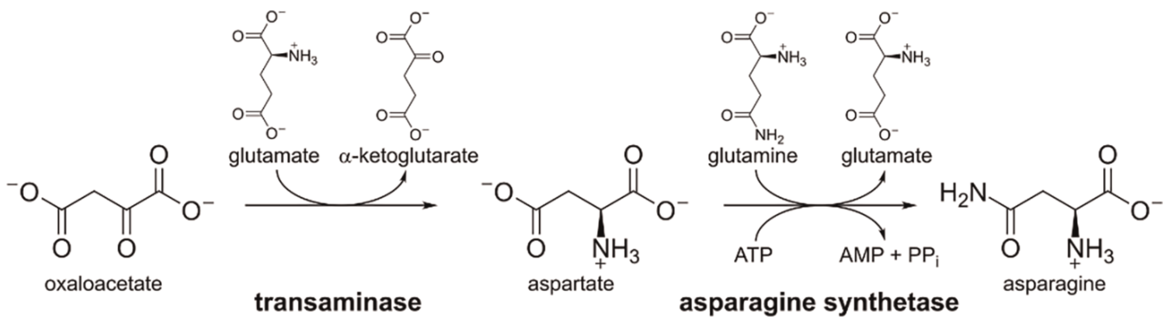

Figure 9.
The biosynthesis of aspartate and asparagine from oxaloacetate. Source: Google images.

6.1.4 Metabolisms of phosphate-containing compounds

Time of germination in days	Dry seeds	1	2	4	6
Phytin	8.6	8.5	7.2	4.0	2.0
Inorganic-P	0.4	0.3	1.9	4.8	7.0
Total lipid	0.7	0.8	0.9	0.5	0.85
Ester	0.3	0.4	0.4	0.6	0.4
RNA	0.12	0.11	0.15	0.25	0.39
DNA	0.11	0.11	0.12	0.21	0.44
Protein	0.11	0.10	0.16	0.28	0.26

Figure 10.
Metabolism of phosphate content in healthy seeds (source: Prof. Dr. Heshmat Aldesuquy biology lectures).

6.2 Metabolism of nucleic acid

The nucleic acid metabolism will give the important secondary metabolites like monomers of portions as given here (**Figures 10–15**) [5–7].

6.2.1 Synthesis of amino acid

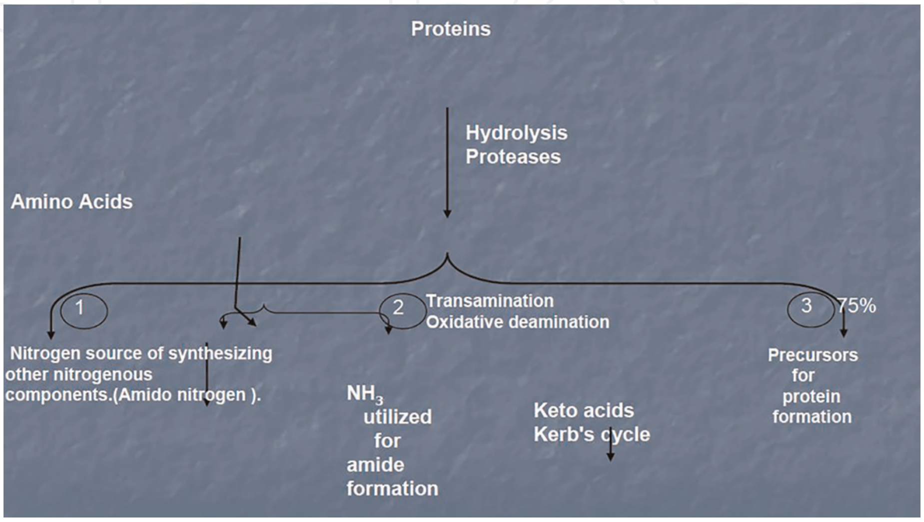

Figure 11.
Formations of monomers of amino acids source (source: Prof.Dr. Heshmat Aldesuquy biology lectures).

6.2.2 Reductive amination

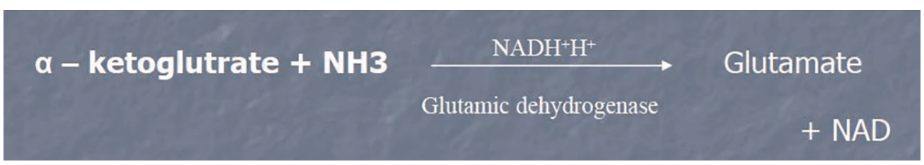

Figure 12.
Formation of glutamine (source: Prof.Dr. Heshmat Aldesuquy biology lectures).

6.2.3 Trans amination

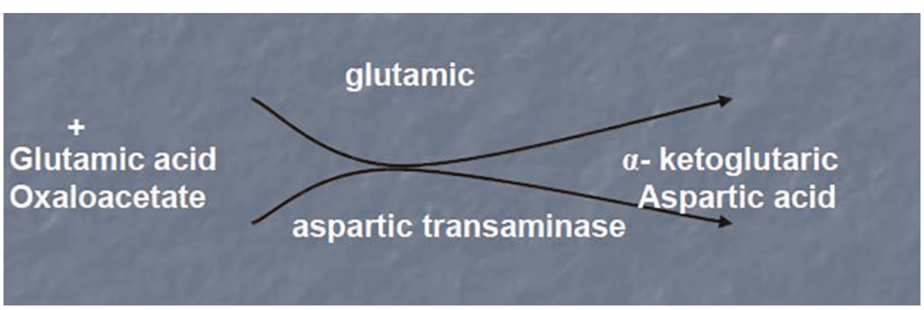

Figure 13.
Formation of aspartic acids (source: Prof.Dr. Heshmat Aldesuquy biology lectures).

6.2.4 Amidase synthesis

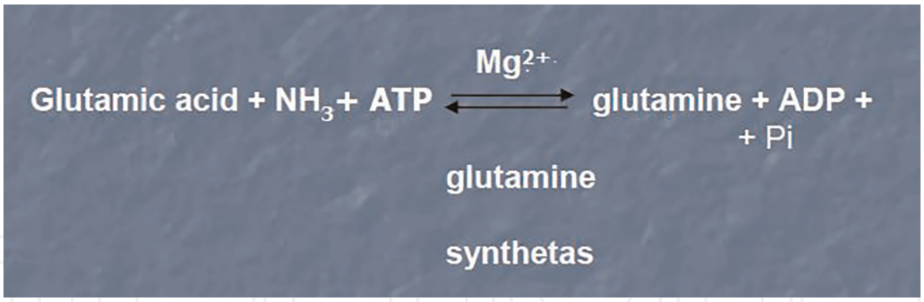

Figure 14.
Formation of glutamine (source: Prof.Dr. Heshmat Aldesuquy biology lectures).

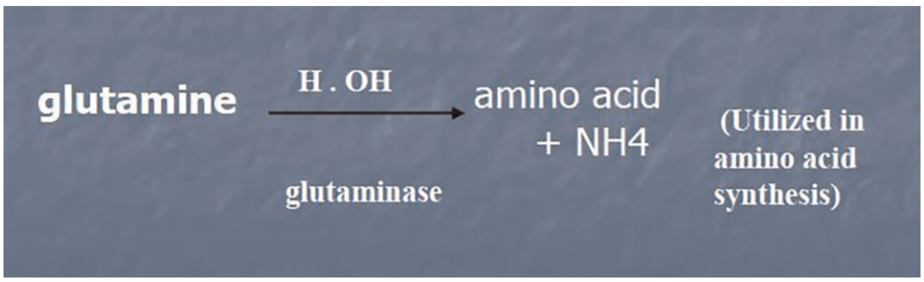

Figure 15.
(source: Prof.Dr. Heshmat Aldesuquy biology lectures).

7. Germination stimulating inhibitors affect in chemical composition

The constituents which inhibit while germination are gabrillic acid (IAA) and indoleic acetic acid (GAB3B) and kinase have been widely investigated as other precursors of germination Auxins, Gibberellins, Cytokinines, Abscisic acid (ABA), Ethylene and effect of coumarin and thiourea. Factors affecting germination viability and life span, external factors affecting life span, stage of germination includes phase activation, digestion and translocation. Epicotyl and hypocotyl germination. This is the stage where seeds can be protected from denaturation and fermentation [8]. This is as discussed in the chapter at the beginning.

Tables: Seed biology with important phytoconstituents [9, 10].

8. Conclusions and future study

1. The remarkable development and environmental factors represents the qulity of seed dormancy and germination. The review explaines the indepth process of seedlings transition phase from development to metabolic growth of bioactives in healthy seeds.

2. Furthermore the hormone ABA is essential for development of seeds until the condition become favorable. This background analysis not only put forward the metabolic process in healthy developed seeds, but also helps agriculturist & phytochemist to choose an healthy seeds to isolate vigor repository in nutshell.

3. The well evalvated seed will be the perfect repository of secondry metabolites which helps to Maintaining of healthy lifestyle by combate with the disorder and disease associated with the leaving species.

4. Whatever this seeds floting on water, blown with air, carried away by animal or choosen by scientist they are the healthy babys (Seeds) scattered to expanding the geography and phytochemistry, thus avoiding the competation with parent plant.

5. To be conclusion the highly ranked seeds eliminate water requirement during sexual reproduction and allow fertilization events to occurs over long distance, where as the seeds of different plant needs different pretreatment to get vigor seedling for production of healthy crops even to isolation the healthy biomolecules.

6. We endup by saying real attention to be focused on plant propagation, particularly indigenous tree species and seedling multiplication should be our preamble to make sustainable environment. if environment is sustainable the life science research will flowrished in right way.

9. Future aspects

The regulatory issues facing both protection and maintenance, will make industry ready seeds, which will be healthy foods with proper nutrients. Hence it was a great deal to focus on seed production, protection and maintenance. The phytochemistry play an impotent role to isolate the bioactive from healthy seeds based on their metabolic pathway able to isolate different macromolecules and micromolecules which can be converted into drug molecule with food value which do not produce any kinds of adverse effect on the human physiological system,

Yes seed refuses to die when it get bury it become tree, when dirt through on it will increased its value, when seed wants to rise it dropes everything that is weighing it down. When crushed it will be the property of medicine. Grower-friendly, crop-friendly, environment-friendly and ultimately Drug molecule-friendly.

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Conflict of interest

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Notes/Thanks/Other declarations

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Acronyms and Abbreviations

ACC	acetyl-CoA carboxylase
FAS	fatty acid synthetase
SAD	stearoyl-ACP desaturase
ODS	oleoyl-phosphatidylcholine desaturase
LDS	Linoleoyl-Phosphatidylcholine desaturase
PC	Phosphatidylcholine
ATP	Adenosine triphosphate
ABA	Abscisic acid

Author details

Nikhat Farhana[1]*, Ripudaman M. Singh[2], Mohammed Gulzar Ahmed[1], Thouheed Ansari[3], Abdul Rahamanulla[1], Ayesha Sultana[1], Treesa P. Varghese[1], Ashwini Somayaji[5] and Abdullah Khan[4]

1 Department of Pharmaceutical Chemistry, Yenepoya Pharmacy College and Research Center, Yenepoya (Deemed To Be University) Mangalore, India

2 UIPS, Chandigarh University, Gharuan, Punjab, India

3 Dr. Noor Mohammed Khan General Hospital, Hafr Al Batin, KSA

4 Centre of Excellence for Pharmaceutical Sciences (CoEPS), School of Pharmacy, KPJ Healthcare University College, Nilai, Malaysia

5 Nitte University, Mangaluru, India

*Address all correspondence to: nik.nida13ada25@gmail.com

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