pertumbuhan Pseudomonas aeruginosa dan Bacillus cereus, yaitu memberikan diameter daerah inhibisi 6,5 cm. Uji sitotoksis memberikan IC₅₀ lupeol > 3 μg/ml dan IC₅₀ marmin > 10 μg/ml. Hal ini menunjukkan bahwa lupeol dan marmin pada kadar tersebut mampu menghambat pertumbuhan sel kanker T-lymphoblastic leukemia hingga 50% dibandingkan dengan kontrol.

KESIMPULAN
Dengan cara pemisahan tersebut di atas maka dapat ditemukan adanya lupeol dan marmin dari korteks Aegle marmelos. Kedua senyawa tersebut tidak mempunyai aktivitas antimikroba. Namun lupeol bersifat signifikan sitotoksis terhadap sel kanker T-lymphoblastic leukemia, sedangkan marmin berefek lemah.

PUSTAKA ACUAN


MINIREVIEW
GIBBERELLIN: ITS ROLE AND INVOLVEMENT IN CEREAL'S SEED DEVELOPMENT

Kumala Dewi*

INTRODUCTION
As the number of population in the world is continually increasing, the need for fulfilling the food demand also increases correspondingly. Many kinds of cereals can be used as a food source such as maize, wheat, barley or rice. Many researchers in various countries have tried to increase the yield or harvest index of cereals in many ways.

The yield of certain seed is determined by both internal factors and external factors. Internal factors include the genetic background and hormones content while external factors include the nutrient available and other environment stresses such as drought, salinity and cold climate.

Five kinds of plant hormones already well know namely Auxin, Gibberellin, Cytokinim, Abscisic acid and Ethylene. Gibberellin which was firstly identified by a Japanese researcher has been widely understood for its biosynthesis and its role during plant growth and development. The role of Gibberellin on vegetative growth has been evaluated in many species while the role of Gibberellin on seed development, especially its role and involvement on the photoassimilate partitioning still need to be elucidated and clearly understood.

THE IMPORTANCE OF SEED
Plant reproduction can be achieved through vegetative reproduction or generative reproduction. Vegetative reproduction can be done by many ways such
as cutting, grafting or tissue culture technique, but for generative reproduction it can be done only through seed formation. Since seeds have a crucial role as a tool for generative plant reproduction, its growth and development usually is considered as the most important process. Developing seed itself is a strong sink. I would define sink as a plant's part that requires photoassimilates for its growth and development. According to Zamski (1995), this is due to the fact that all genetic information necessary for normal growth of the plant should be contained in that seed. This argument can be accepted since to synthesize all the genetic information that should be contained in the seed, a lot of energy is required on this energy comes from photoassimilates.

The movement of photoassimilates from the source (usually leaves) to the different sink (roots, flowers, fruits and seeds) can be regulated at numerous points, altering the photoassimilates allocation can be achieved after the basic mechanism of photoassimilates allocation has been understood. This opinion is correct since many factors, such as hormonal factors or the constituent of photoassimilates itself must influence the movement of photoassimilates from the source to the sink. It has been found that developing seeds contain higher concentration of plant hormones compared to other plant's part, and it is assumed that hormones play a direct or indirect role in photoassimilates allocation (Brenier, 1987 in Zamski, 1995).

HORMONES AND SEED FORMATION

The seed formation that is usually referred to the reproduction growth can not be separated from the vegetative growth. In other words the quality of vegetative growth, in many ways determines also the quality of seed produced. It has long been understood that both vegetative and generative phase of plant growth and development are regulated by plant hormones, while the production of plant hormones as well as the response they elicit in the plant depend on both genetic and environmental factors. Amongst the five known plant hormones, Gibberellin is considered as an important regulator of vegetative growth. The main effect of Gibberellin on vegetative growth is on regulating the stem or internodes elongation and leaf expansion. This effect can be seen clearly from Gibberellin-deficient dwarf mutant that can grow as a normal plant after treated with an active Gibberellin (Chandler & Robertson, 1999). The other hormone that usually promotes plant growth is Auxin and Cytokinins, while the two other hormones - Abscisic acid and Ethylene usually limit the growth of plant. However, in interpreting the role of hormones we cannot just rely on the effects performed by one kind of hormone. All kinds of hormones work in an orchestrated fashion to give the final form of plant growth and development.

Eventhough many research have proved that Gibberellin has the ability to stimulate plant's growth and development, several questions remains to be answered, especially related to the role of Gibberellin on seed development. In cereal it is has been suggested that there is a competition in gaining photoassimilates between the vegetative plant's part and reproductive plant's part, especially during the phase of flower formation and also during the fertilization, since the potential seed number is established in this phase (Hendric et al., 1986 in Zamski, 1995). In agricultural practices, it has also become common to manipulate the vegetative growth either genetically or by application of growth regulators, in order to increase the seed yield. It has been found that application of growth retardants (that usually are inhibitors of Gibberellin biosynthesis) can improve the yield of cereal such as Lolium perenne L. (Young et al., 1996). This result implies that seed yield can be improved through limitation or reduction of Gibberellin level in the vegetative plant's part. It can also be assumed that growth retardant is able to reduce the level of Gibberellin that lead to the reduction of vegetative growth but without reducing the photosynthetic rate, thus the photoassimilates produced can be translocated more to the reproductive plant's part rather than vegetative plant's part. But these several questions will come such as (1) when and to what level does Gibberellin should be limited in order that the seed yield can be maximized?, (2) does the reduction of Gibber-
ellin level affect the photosynthesis rate, or promote the synthesis of another hormone that can increase the photoassimilates translocation?, (3) Will the result be similar if Abscisic acid is applied instead of growth retardant? (based from the assumption that Abscisic acid usually counteract the activity of Gibberellin).

Seed develop from the ovule and contains the embryo and endosperm. The clear example of the seedless fruit that can be formed by application of Gibberellin or Auxin show that these two kind of hormones are involved as well in seed development. In Barley, it has been found that there is a fluctuation on the level of hormones during seed development (Chandler & Robertson, 1999). A peak of Cytokinins was found in the first week after fertilization occurred. This finding is reasonable since the function of Cytokinin is mainly for cell division. During the early stage of seed growth, cell division occurs first and then the cells (more exactly the vacuole cell) are filled with photoassimilates which later on become storage materials. It has been suggested that Cytokinins regulated the transport of photoassimilates in the vegetative plant's part, however, it still need to be examined whether Cytokinins also promote the photoassimilates allocation to the developing seed and whether this promotion is directly or indirectly.

The peak of Auxin comes later (about 8-20 days after fertilization) or at the time when rapid grain filling occurs. It was also considered that Auxin stimulates photoassimilates allocation both to and within developing grain (Chandler & Robertson, 1999). However, whether Auxin acts directly or indirectly still need to be evaluated as well. In vegetative growth, Auxin has role in cell elongation process. This process of course need an energy and the energy obtained from photoassimilates. It can be argue that probably in developing seed as well as in vegetative tissue, Auxin stimulates the photoassimilates allocation indirectly.

The occurrence of endogenous Gibberellin and Abscisic acid during grain development has been proved (Gaskin et al. (1984) and King (1982) in Green et al., 1997). The grain Gibberellin often present at a very high level compared to the other vegetative plant's part (Chandler & Robertson, 1999). As seed has a value as a tool for plant propagation, the occurrence of all kinds of hormones or its precursors is a normal phenomena. The new plant should be able to synthesize all kinds of hormone needed for its growth and the precursor of these hormones should be available in every seed. With Gibberellin. It has been claimed that grain seed germination process requires Gibberellin for triggering the production of a-amylase-an enzyme that needed to break up the storage materials so that it can be used as a source of energy for germination process (Green et al., 1997). The assumption that Gibberellins are also important in grain growth comes from the finding that a grain mutant (GA-deficient dwarf M117) grows more slowly and achieve smaller final dry weight compared to the wild type. However, this assumption can be argued since the role of Gibberellin in cell growth is mainly in reducing the time needed for cell cycle (or in other word Gibberellin can increase the number of cell), thus if the mutant is deficient in Gibberellins and the final dry weight is smaller compared to the less photoassimilates allocation to the developing seed. Furthermore, referring to the result that growth retardant (or an inhibitor of Gibberellin biosynthesis) can improve the seed yield, it is reasonable to assume that the Gibberellin in the seed is probably need only for the germination process and not directly affect the photoassimilate allocation to the developing seed. This assumption is derived from the other finding that a certain mutant in barley (GA-deficient loci) has normal grain Gibberellin content but has a smaller grain size compared to the wild type.

Abscisic acid probably has a direct effect on the photoassimilates allocation to the developing seed. This assumption is based again on the finding that growth retardant can improve the seed yield cereals (Young et al., 1996). Abscisic acid has been found to act antagonistically with Gibberellin and it seems that Abscisic acid can play a similar role as the growth retardant. The other known function of Abscisic acid in the seed is to prevent the early germination and to promote seed maturation.
(White et al., 2000). It becomes interesting to further examine the relation between Gibberellin and Abscisic acid during the seed development. These two hormones share the same precursor but their action usually counteract each other. It is also interesting to test whether the mutant (GA-deficient loc) that has a smaller grain size but has a normal grain Gibberellin will also increase their size if applied with an abscisic acid or growth retardant.

Regardless all the possibilities of the role or involvement of hormones in grain development, another question still remain to be answered as well, namely whether the the hormones detected in the seed merely come from the vegetative plant's part or does the seed cells able to synthesize these hormone as well.

REFERENCES


