Absorbable Polymers from Soybean Isoflavonoids for Biomedical Applications

Rao S. Bezwada

Bezwada Biomedical, LLC, P.O. Box 6357, Hillsborough, New Jersey, NJ 08844

INTRODUCTION

We report for the first time development of novel absorbable polymers from isoflavonoids found in soybean. Isoflavonoids are a subgroup of flavonoids that occur only in plants. They exhibit tremendous potential to fight against number of diseases. They are a type of phyto estrogen with chemical structure similar to hormone estrogen. Although a number of isoflavonoids isolated from different plants have been studied, this paper will focus on soybean isoflavonoids. Soybean isoflavonoids found mainly in soybeans are known to posses numerous biological activities. For example, soybean isoflavonoids play an important role in protecting and maintaining strong and healthy bones by improving bone mass and reducing bone resorption. They also act as anti-oxidants to counteract damaging effects of free radicals in tissues. They are also known to prevent the build up of arterial plaques, which reduce the risk of coronary heart disease, and associated cardiovascular complications. In addition, soybean isoflavonoids help reduce breast cancer by blocking the cancer causing effects of human estrogen. They may also prevent prostate cancer by hindering cell growth. Genistein and Daidzen are the two most beneficial isoflavones found in soybeans.

The widespread availability and therapeutic applications of soybean isoflavonoids such as Daidzein and Genistein motivated us to enhance their native value, by functionalizing them with safe and and biocompatible molecules such as glycolic acid, lactic acid, p-dioxanone and caprolactone. These molecules are the building blocks of majority of biodegradable polymers used to make commercial medical devices such as sutures, staples, orthopedic screws and implantable surgical devices to tissue engineering scaffolds. These functionalized soybean isoflavonoids were then utilized to prepare biodegradable polymers in order to incorporate their therapeutic values in the polymer backbone chain. The resulting polymers have controlled degradation profile and will enable us to meet the unmet requirements in medical device and cosmetic industry.

Key aspects of these novel polymers having combined attributes of biodegradable polymers and therapeutic properties of soybean isoflavonoids will be discussed. Synthesis and characterization of these polymers will be presented. Preliminary results from invitro hydrolytic degradation studies will also be presented. We believe that innovative technology behind these polymers will enable us to make absorbable drug delivery systems that can deliver the therapeutic properties of soybean isoflavonoids.

RESULTS AND DISCUSSION

Functionalization of Soybean Isoflavonoids. Daidzein and Genistein as shown in Figure 1 (a) and (b) respectively, were conjugated with glycolic acid by both Williamson etherification and esterification. This functionalization resulted in the formation of corresponding novel monomers derived from soybean isoflavonoids as shown in figures 1(c) to 1(f). Functionalized Daidzein monomers were then subjected to condensation polymerization to yield novel absorbable polymers containing soybean isoflavonoids in the backbone as shown in figure 2 (a)-(b). Furthermore, in order to vary the hydrolytic degradation rates of these polymers the natural product molecules were functionalized with multiple repeat units of glycolic acid as represented in Figure 2(b). Functionalized Genistein monomers can be used as crosslinker.

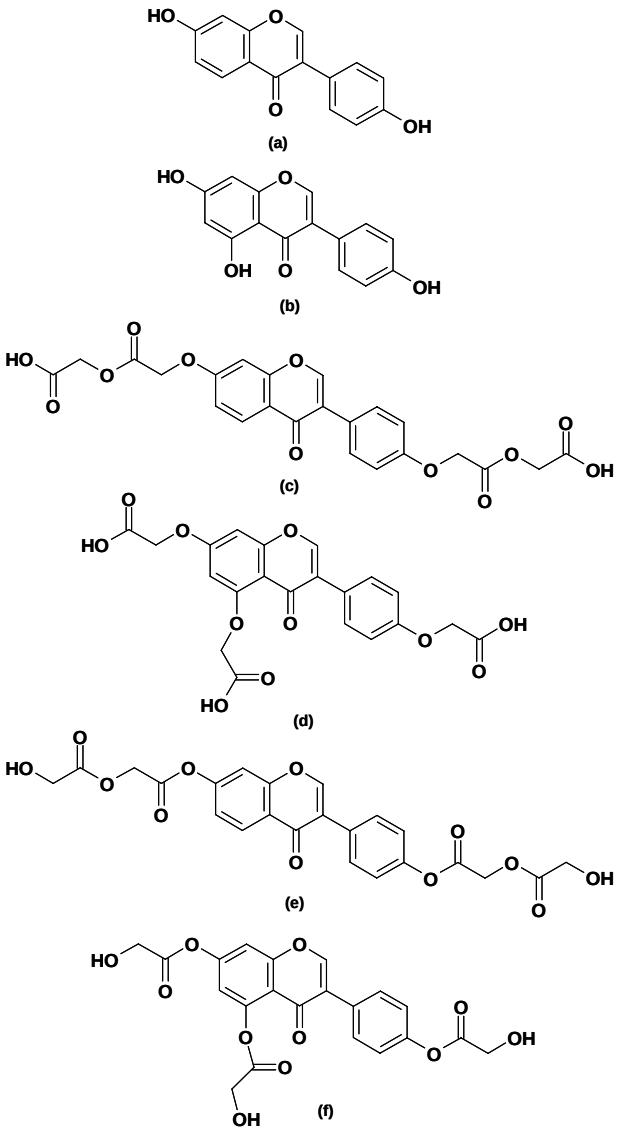

Figure 1. (a) Daidzein (b) Genistein (c) Glycolic acid functionalized Daidzein via etherification (d) Glycolic acid functionalized Genistein via etherififcation (d) Glycolic acid functionalized Daidzein via esterififcation (e) Glycolic acid functionalized Genistein via esterification

All the functionalized soybean isoflavonoid monomers and the polymers derived from them were characterized using NMR spectroscopy. The details of the monomer and polymer synthesis and their characterization will be presented in detail in the meeting. In vitro hydrolytic degradation rates for different polymers derived from soybean isoflavonoids will be presented during the meeting.

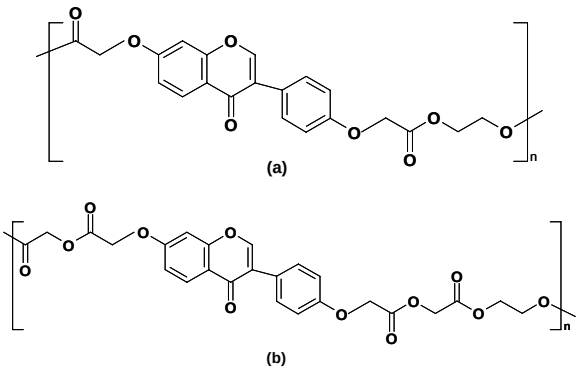

Figure 2. (a)-(b) Absorbable polymer from glycolic acid functionalized daidzein and ethylene glycol with different hydrolytic degradation rates.

CONCLUSIONS

In this paper we report for the first time the development of absorbable polymers and cross-linkers from functionalized soybean isoflavonoids. These polymers are designed to degrade into safe and biocompatible molecules along with soybean isoflavonoids. These polymers will find potential applications in drug delivery, polymer therapeutics and cosmetic applications. We believe that innovative technology behind these polymers will enable us to make absorbable drug delivery systems that can deliver the therapeutic properties of soybean isoflavonoids.

REFERENCES

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