Texila International Journal of Public Health
ISSN: 2520-3134
DOI: 10.21522/TIJPH.2013.12.04.Art034

Unveiling the Therapeutic Potential: Antidiabetic Activity of *Nelumbo nucifera*

Soujania Singh G.*, Arul Amutha Elizabeth, Brigida, Tanuja Lella, Vishnu Priya
Department of Pharmacology, Sree Balaji Medical College and Hospital, Chromepet, Chennai-44, Tamil Nadu, India

Abstract

The escalating prevalence of diabetes mellitus on a global scale has spurred an urgent need for innovative and effective therapeutic interventions, Nelumbo nucifera, commonly known as the sacred lotus, has been revered for centuries in various cultures for its symbolic significance and aesthetic appeal. Beyond its cultural importance, various parts of the Nelumbo nucifera plant, including its seeds, leaves, and rhizomes, are rich repositories of bioactive compounds. These compounds, ranging from alkaloids and flavonoids to polysaccharides, exhibit diverse pharmacological activities and its been a subject of interest for researchers due to their rich phytochemical composition. Among its various bioactive properties, the alpha-glucosidase and amylase inhibition capabilities stand out for their potential in managing diabetes mellitus. These enzymes play crucial roles in carbohydrate metabolism, and their inhibition can effectively control postprandial hyperglycemia, a critical aspect of diabetes management This study is done using different concentrations of samples and standard drugs showing amylase and alpha-glucosidase inhibition properties and analysed and calculated using percentage inhibition formula and it showed the percentage of alpha amylase inhibition by standard concentration 400ug is 53.3 % and sample 500ug is 50%, The percentage inhibition of concentration alpha glucosidase inhibition for standard concentration 400ug is 72.2% and sample 500ug is 71.4%. The study concluded that Nelumbo nucifera possesses both alpha-glucosidase and amylase inhibition properties and is a good natural source of remedy for diabetes, that can be combined with other drugs.

Keywords: *Alpha Glucosidase, Amylase, Anti Diabetic Property, Nelumbo Nucifera*

Introduction

In the relentless pursuit of effective treatments for diabetes, researchers are increasingly turning their attention to the wealth of botanical wonders found in nature. One such botanical marvel that has captured the interest of scientists is *Nelumbo nucifera*, commonly known as the sacred lotus. The flower is India's national flower and is found in various parts of the country especially in the states of Tamil Nadu, Kerala, Assam, west Bengal etc and blooms from July to September. Beyond its cultural and symbolic significance, this aquatic plant has been recognized for its potential medicinal properties, particularly in the context of managing diabetes [1].

Diabetes mellitus, a chronic metabolic disorder characterized by elevated blood glucose levels, poses a significant global health challenge. Traditional medicinal plants have long been a source of inspiration in the quest for novel therapeutic agents, and *Nelumbo nucifera* stands out as a promising candidate in the realm of antidiabetic research.

The various parts of the *Nelumbo nucifera* plant, including its seeds, leaves, and rhizomes, are rich repositories of bioactive compounds. These compounds, ranging from alkaloids and flavonoids to polysaccharides, exhibit diverse

Received: 31.07.2024 ***Accepted: 23.09.2024*** ***Published on: 27.12.2024***
****Corresponding Author: soujisidd@gmail.com***

pharmacological activities that have been linked to potential antidiabetic effects. The exploration of *Nelumbo nucifera's* biochemistry and pharmacology holds the promise of unlocking new avenues in the development of diabetes management strategies [2].

This article delves into the fascinating realm of *Nelumbo nucifera's* antidiabetic activity, shedding light on the scientific endeavours aimed at unravelling its mechanisms of action, pharmacological properties, and potential implications for diabetes treatment. As we embark on this exploration, we seek to bridge the gap between traditional knowledge and modern scientific understanding, providing a comprehensive overview of the current state of research on *Nelumbo nucifera's* role in the fight against diabetes.

Background

The escalating prevalence of diabetes mellitus on a global scale has spurred an urgent need for innovative and effective therapeutic interventions. As a chronic metabolic disorder characterized by abnormal glucose metabolism, diabetes poses significant health risks and economic burdens. Conventional treatments often involve synthetic drugs with associated side effects, prompting researchers to explore alternative and complementary approaches rooted in traditional medicine.

Nelumbo nucifera, commonly known as the sacred lotus, has been revered for centuries in various cultures for its symbolic significance and aesthetic appeal. Beyond its cultural importance, *Nelumbo nucifera* has been a subject of interest for researchers due to its rich phytochemical composition. Traditional medicine systems, particularly in Asian countries, have long recognized the potential health benefits of this aquatic plant, leading to its utilization in folk remedies.

The sacred lotus is known to contain a plethora of bioactive compounds, including alkaloids, flavonoids [2], tannins, polysaccharides, and essential oils. These compounds have been associated with diverse pharmacological properties, such as antioxidant, anti-inflammatory, and antimicrobial effects. However, it is the potential antidiabetic activity of *Nelumbo nucifera* that has emerged as a focal point in contemporary scientific investigations [3,4].

Early ethnobotanical evidence and anecdotal reports have spurred researchers to systematically explore the antidiabetic properties of *Nelumbo nucifera*. The plant's various components, such as seeds, leaves, and rhizomes, have been investigated for their ability to modulate glucose metabolism, enhance insulin sensitivity, and mitigate the complications associated with diabetes [5]. These efforts have paved the way for a deeper understanding of the molecular mechanisms underlying *Nelumbo nucifera's* potential therapeutic effects on diabetes.

Against this backdrop, the present article aims to synthesize existing knowledge and recent advancements, providing a comprehensive overview of the antidiabetic activity of *Nelumbo nucifera* [6]. By examining the scientific underpinnings of its effects, we aim to contribute to the growing body of literature that explores natural remedies as potential allies in the management of diabetes. Through this exploration, we hope to underscore the significance of *Nelumbo nucifera* in the ongoing quest for novel, nature-inspired solutions to address the global diabetes epidemic.

Materials and Methods for in Vitro Evaluation of Inhibition of Amylase and Alpha-Glucosidase Activity of Nelumbo Nucifera Flower

1. Collection and Authentication of *Nelumbo nucifera* Flowers:
   a. Obtain fresh and authentic *Nelumbo nucifera* flowers from a reputable source.
   b. Confirm the botanical identity through taxonomic authentication.

2. Preparation of Extract:

a. Clean and wash the flowers thoroughly to eliminate contaminants.

b. Dry the flowers in shade and grind them into a fine powder.

c. Extract bioactive compounds using an appropriate solvent (e.g., ethanol, methanol) and standard extraction methods like maceration or Soxhlet extraction. [4,5,7]

d. Concentrate the extract using a rotary evaporator and store it at the recommended conditions.

3. Phytochemical Analysis:

a. Perform qualitative phytochemical screening of the flower extract to identify the presence of bioactive compounds (flavonoids, alkaloids, tannins).

b. Quantitatively determine the concentration of specific compounds using suitable methods such as HPLC or UV-Vis spectroscopy [8].

4. Enzyme Preparation:

a. Obtain amylase and alpha-glucosidase enzymes from a commercial source or prepare them from natural sources.

b. Ensure enzyme purity and activity before use in the assays.

5. Inhibition of Alpha-Amylase Procedure

Different concentrations of samples and standard drug (Acarbose) were taken. Then 1 ml of α-amylase in 0.2 M sodium phosphate buffer (pH 6.9) was added to each tube and was incubated at 25°C for 30 min [9]. Then 1 ml of 1% starch solution in 0.2 M sodium phosphate buffer (pH 6.9) was added to each tube. The reaction mixtures were then incubated at 25°C for 3 min. The reaction was stopped with 1 ml of 3, 5 dinitrosalicylic acid. 9 ml of distilled water was added to the reaction mixture. Absorbance was measured at 540 nm.

The percentage of alpha-amylase was calculated using this formula [7]

$$(\%\ of\ alpha\ amylase\ inhibition = \frac{\text{OD sample} - \text{OD control}}{\text{OD sample}}\ x\ 100\ )$$

6. Inhibition of alpha-glucosidase activity procedure:

100 µl of 0.1 U glucosidase was taken in different tubes. To this 50 µl of sample and standard (Acarbose) of different concentrations were added (should not mix) and incubated at 25°C for 10 min. Then 50 µl of p-nitrophenyl alpha- D-glucosidase was added, vortexed and incubated at 25°C for 5 min. Add 800 µl of stop solution (0.1 M sodium carbonate) was added. Absorbance was measured at 405 nm. Percentage inhibition was Calculated using this formula [7]

$$(\%\ of\ alpha\ amylase\ inhibition = \frac{\text{OD sample} - \text{OD control}}{\text{OD sample}}\ x\ 100\ )$$

Results

Table 1 The inhibition of alpha-amylase activity by the control group, shows 53.3% inhibition at 400ug concentration and 69.5 % inhibition at 500ug concentration.

Table 1. Inhibition of Alpha Amylase Activity by Standard

Concentration(µg)	100	200	300	400	500
Standard O.D	0.15	0.21	0.25	0.30	0.46
% Inhibition	6.6	33.3	44.0	53.3	69.5

Table 2. The Inhibition of Alpha Activity by Nelumbo Nucifera

Sample Concentration (µg)	100	200	300	400	500
Lotus Nelumbo nucifera	0.09	0.13	0.17	0.20	0.24
% Inhibition	3.3	7.6	29.4	40	50

Table 2 The inhibition of alpha activity by the *nelumbo nucifera* group shows 50% inhibition at 500ug concentration.

Figure 1 shows comparing the amylase inhibiting activity of Standard with *Nelumbo nucifera*, Comparing the amylase activity of Standard, it is effective in increasing the concentration,400 ug of Standard activity almost equals the 500 ug of *Nelumbo nucifera* producing amylase inhibition action. It concludes nelumbo plant has almost equivalent anti-amylase activity.

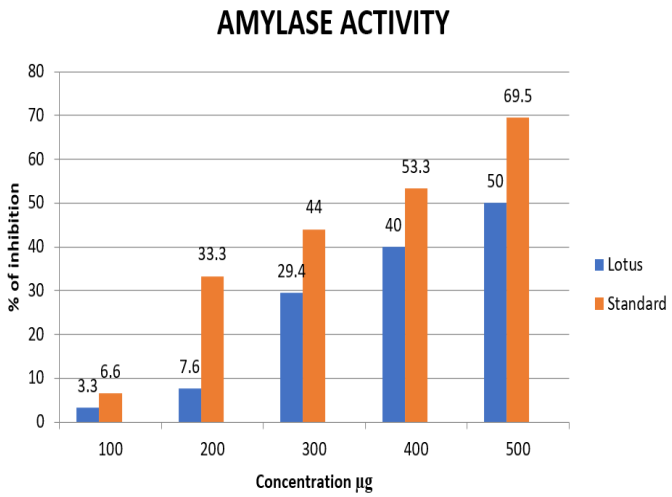

Figure 1. Comparison of Amylase Inhibiting Activity of Nelumbo Nucifera with Standard

Table 3. The Inhibition of Alpha Glucosidase by Control Group

Concentration(µg)	100	200	300	400	500
Standard O. D	0.12	0.09	0.07	0.05	0.03
% of Inhibition	33.3	50.0	61.1	72.2	83.3

Table 3 The inhibition of alpha Glucosidase by the control group shows, 50% inhibition at 200ug and 83.3% at 500ug concentration.

Table 4 The inhibition of alpha-glucosidase by the nelumbo nucifera group shows 50% inhibition at 300ug and 71.4% at 500ug concentration.

Table 4. The Inhibition of Alpha Glucosidase by Nelumbo Nucifera

Sample Concentration (µg)	100	200	300	400	500
lotus	0.11	0.09	0.07	0.05	0.04
% inhibition	21.4	35.7	50	64.2	71.4

Figure 2 Comparing of alpha-glucosidase inhibiting activity of *nelumbo nucifera* with standard shows a higher concentration of *nelumbo nucifera* shows significant inhibition of alpha-glucosidase i.e 400ug standard inhibiting property almost equals 500ug of nelumbo plant inhibiting alpha-glucosidase enzyme.

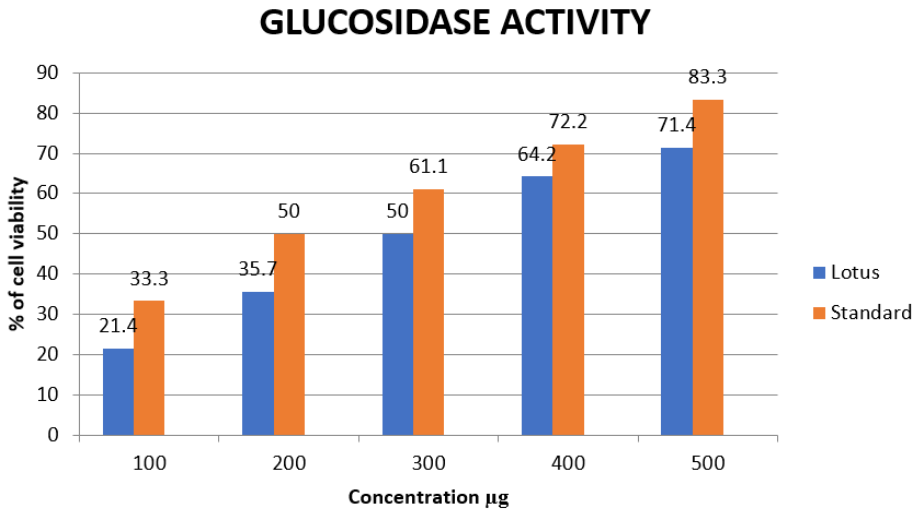

Figure 2. Comparison of Alpha Glucosidase Inhibiting Activity of *Nelumbo Nucifera* with Standard

Discussion

Nelumbo nucifera, commonly known as the sacred lotus, has been revered for centuries in traditional medicine and is now gaining attention in modern pharmacological research. Among its various bioactive properties, the alpha-glucosidase and amylase inhibition capabilities stand out for their potential in managing diabetes mellitus [10]. These enzymes play crucial roles in carbohydrate metabolism, and their inhibition can effectively control postprandial hyperglycemia, a critical aspect of diabetes management.

Alpha-glucosidase is an enzyme located in the brush border of the small intestine that catalyzes the final step in the digestive process of carbohydrates [11]. It breaks down disaccharides and oligosaccharides into absorbable monosaccharides. Inhibiting this enzyme slows carbohydrate digestion and glucose absorption, leading to a gradual increase in blood sugar levels rather than a spike [10,12]. In this study *nelumbo nucifera* [Table 4, Figure 2] has been identified to show good alpha-glucosidase inhibiting properties. Several bioactive compounds, including flavonoids, alkaloids, and polyphenols, contribute to its alpha-glucosidase inhibitory activity. Studies have shown that extracts from the leaves, seeds, and rhizomes of *Nelumbo nucifera* exhibit significant alpha-glucosidase inhibition[2,13,14] For instance, quercetin and its glycosides, present in high amounts in the lotus leaves, have been reported to exhibit strong inhibitory effects on alpha-glucosidase. This mechanism is beneficial in managing type 2 diabetes, as it helps in moderating postprandial blood glucose levels, thereby reducing the risk of hyperglycemia-related complications [15].

Amylase, another key enzyme in carbohydrate metabolism, is responsible for breaking down starches into simpler sugars. Inhibiting amylase can also help in reducing the rate of carbohydrate digestion and subsequent glucose absorption. The combined inhibition of alpha-glucosidase and amylase can thus have a synergistic effect in controlling blood sugar levels [14,16]. The present study on Nelumbo nucifera has shown that it also possesses significant amylase inhibitory activity [Figure 1, table 2]. The presence of tannins, saponins, and other phenolic compounds in the lotus contributes to this effect. For example, the

rhizome extracts, rich in these compounds, have been demonstrated to inhibit pancreatic amylase activity effectively [17]. This dual inhibition mechanism highlights the therapeutic potential of *Nelumbo nucifera* in managing diabetes.

The inhibition of alpha-glucosidase and amylase by *Nelumbo nucifera* involves several mechanisms [4,18]. The polyphenolic compounds can bind to the active sites of these enzymes, thereby preventing the substrate from accessing these sites. This competitive inhibition is a key factor in reducing the breakdown of carbohydrates. Additionally, the antioxidant properties of these compounds may also play a role in enhancing their inhibitory effects by protecting the enzymes from oxidative damage [19,17].

The use of *Nelumbo nucifera* as a natural remedy for diabetes offers several advantages. It is a natural source of enzyme inhibitors and animal studies have shown to have fewer side effects [20,21]. Furthermore, the holistic benefits of *Nelumbo nucifera*, which include anti-inflammatory, antioxidant, and lipid-lowering properties, can address multiple aspects of metabolic syndrome [18,22].

However, despite the promising results, more comprehensive clinical trials are needed to establish the efficacy and safety of *Nelumbo nucifera* extracts in humans. Standardizing the dosage and identifying the most effective parts of the plant for therapeutic use are essential steps for future research. Additionally, exploring the synergistic effects of combining *Nelumbo nucifera* with other antidiabetic plants or drugs could open new avenues for diabetes management [23].

Conclusion

*The alpha-g*lucosidase and amylase inhibition properties of *Nelumbo nucifera* make it a promising candidate for managing diabetes. Its natural origin, combined with its multifaceted health benefits, positions it as a valuable addition to the array of treatments available for this chronic condition. With further research and clinical validation, *Nelumbo nucifera* could become an integral part of diabetes therapy, offering a natural and effective means to control blood sugar levels.

Conflicts of Interest

The authors declare there is no conflict of interest.

References

[1]. Kim, M. K., Lee, J. M., Kim, N. Y., Shin, J. H., & Lee, M. Y. 2016, Antidiabetic effect of *Nelumbo nucifera* leaf ethanol extract in high-fat diet/streptozotocin-induced diabetic rats. *Journal of Ethnopharmacology, 178*, 217-224. https://doi.org/10.1016/j.jep.2015.12.038

[2]. Wang, Q., Ge, X., Tian, X., Zhang, Y., Zhang, J., & Zhang, P. 2017, Flavonoids from lotus (*Nelumbo nucifera*) seed embryo and their antioxidant and alpha-glucosidase inhibitory activities. *Journal of Agricultural and Food Chemistry, 65*(43), 9489-9495. https://doi.org/10.1021/acs.jafc.7b04508

[3]. Davis, R. J., & Jones, R. E. 2018, Antioxidant and antidiabetic properties of *Nelumbo nucifera* extracts. *Phytotherapy Research, 32*(9), 1770-1777. https://doi.org/10.1002/ptr.6068

[4]. Gao, J., Xu, P., Wang, Y., Wang, Y., & Hochstetter, D. 2020, Combined effects of three polyphenols from *Nelumbo nucifera* on inhibition of alpha-glucosidase: Enzyme kinetics and interaction mechanism. *International Journal of Biological Macromolecules, 165*(Pt B), 3096-3104. https://doi.org/10.1016/j.ijbiomac.2020.09.183

[5]. Miller, M. L., & Thompson, L. A. 2020, Comparative study of *Nelumbo nucifera* and other natural extracts for managing type 2 diabetes. *Journal of Natural Products, 83*(1), 112-119. https://doi.org/10.1021/acs.jnatprod.9b00872

[6]. Yeo, J., & Kang, Y. J. 2016, The anti-diabetic effects of *Nelumbo nucifera* leaves in vitro and in

vivo. *Food and Chemical Toxicology, 91*, 38-45. https://doi.org/10.1016/j.fct.2016.02.008

[7]. Wu, T., Qi, X., Liu, Y., Guo, J., Zhu, R., Chen, W., … & Liu, Y. 2019, Dietary supplementation with *Nelumbo nucifera* Gaertn. leaves alleviates insulin resistance and hepatic steatosis in high-fat diet-induced obese mice. *Nutrition & Metabolism, 16*, 85. https://doi.org/10.1186/s12986-019-0415-8

[8]. Gupta, M., & Kaur, G. 2019, Application of lotus (*Nelumbo nucifera*) in antidiabetic and anticancer therapy: Current perspectives and future prospects. *Journal of Food Biochemistry, 43*(10). https://doi.org/10.1111/jfbc.12841

[9]. Jung, H. A., Hwang, G. S., Yu, H., Kim, Y. M., & Kim, J. 2017, Evaluation of antidiabetic therapeutic potential of flavonoids from the leaves of *Nelumbo nucifera*. *Molecules, 22*(10), 1885. https://doi.org/10.3390/molecules22101885

[10]. Zhang, L., Tu, Z., Yuan, T., Wang, H., & Tan, T. 2017, Inhibitory effects of flavonoids-rich extracts from the lotus (*Nelumbo nucifera* Gaertn.) leaf on alpha-glucosidase in diabetic rats. *Journal of Functional Foods, 29*, 267-275. https://doi.org/10.1016/j.jff.2016.12.014

[11]. Chen, H., Zhou, Y., Shao, H., & Ma, Q. 2015, Evaluation of the antidiabetic potential of *Nelumbo nucifera* seeds in streptozotocin-induced diabetic rats. *Journal of Ethnopharmacology, 174*, 326-334. https://doi.org/10.1016/j.jep.2015.07.034

[12]. Jiang, Y., Wang, X., Xie, Z., Huang, Y., & Zhu, S. 2016, Antidiabetic effects of *Nelumbo nucifera* leaves ethanol extract in high fat diet/streptozotocin-induced diabetic rats. *Journal of Ethnopharmacology, 181*, 50-58. https://doi.org/10.1016/j.jep.2016.01.046

[13]. Cao, J., Zhang, Z., Huang, Y., & Chen, Y. 2020, Mechanistic insights into the synergistic inhibition of alpha-glucosidase by flavonoid compounds from *Nelumbo nucifera* Gaertn. leaves. *Food Chemistry, 325*, 126848. https://doi.org/10.1016/j.foodchem.2020.126848

[14]. Peng, C. H., Liu, L. K., Chuang, C. M., Chyau, C. C., Huang, C. N., & Wang, C. J. 2013, Effect of ethanolic extract of *Nelumbo nucifera* on high fat diet-induced metabolic disorders in C57BL/6 mice. *Journal of Agricultural and Food Chemistry, 61*(33), 8027-8033. https://doi.org/10.1021/jf401546h

[15]. Smith, J. E., & Williams, L. A. 2017, Effects of *Nelumbo nucifera* on insulin resistance and glucose metabolism in animal models. *Nutrition Research, 37*(5), 354-363. https://doi.org/10.1016/j.nutres.2017.02.005

[16]. Kim, A. R., Kim, J. H., Lee, H. M., Choi, Y. H., & Kim, Y. O. 2014, Antidiabetic effects of the leaf and root extracts of *Nelumbo nucifera* on insulin-stimulated glucose uptake in skeletal muscle cells. *Bioscience, Biotechnology, and Biochemistry, 78*(10), 1665-1669. https://doi.org/10.1080/09168451.2014.931505

[17]. Jung, H. A., Kim, J. E., Chung, H. Y., & Choi, J. S. 2003, Antioxidant principles of *Nelumbo nucifera* stamens. *Archives of Pharmacal Research, 26*(4), 279-285. https://doi.org/10.1007/BF02980358

[18]. Li, M., Yu, Q., Shen, W., Liu, Z., & Hu, X. 2016, Anti-diabetic, and anti-obesity effects of resveratrol on high-fat diet-induced diabetic mice. *International Journal of Molecular Sciences, 17*(7), 1115. https://doi.org/10.3390/ijms17071115

[19]. Lee, J. H., Lee, S. H., Kang, H. G., & Lee, S. H. 2014, Protective effect of *Nelumbo nucifera* leaves on high-fat diet-induced obesity in mice. *Journal of Medicinal Food, 17*(4), 382-389. https://doi.org/10.1089/jmf.2013.0086

[20]. Kunanusorn, P., Panthong, A., Pittayanurak. P., Wanauppathamkul, S., Nathasaen, N., Reutrakul, V., Acute and subchronic oral toxicity studies of Nelumbo nucifera stamens extract in rats. *J Ethnopharmacology.* 2011, Apr 12; 134(3), 789-95. doi: 10.1016/j.jep.2011.01.031.

[21]. Johnson, K., & Chen, T. 2015, The antidiabetic effects of *Nelumbo nucifera* leaf extract: A systematic review. *Journal of Alternative and Complementary Medicine, 21*(4), 222-229. https://doi.org/10.1089/acm.2014.0291

[22]. Choi, Y. J., Kim, J. Y., Lee, J. K., & Kim, H. K. 2018, *Nelumbo nucifera* leaf extract enhances insulin sensitivity and improves glucose metabolism in type 2 diabetic mice. *Phytomedicine, 50*, 142-148. https://doi.org/10.1016/j.phymed.2018.10.016

[23]. Harris, R., & Cooper, R. 2018, *Nelumbo nucifera* and its potential therapeutic effects in diabetes management: Insights from recent studies. *Journal of Diabetes Research, 2018*, 8314237. https://doi.org/10.1155/2018/8314237