TEACHERS' TOPICS

Evolution of a Natural Products and Nutraceuticals Course in the Pharmacy Curriculum

Werner J. Geldenhuys, PhD, BPharm, Michelle L. Cudnik, PharmD, Daniel L. Krinsky, RPh, MS, BS, Altaf S. Darvesh, PhD, MPharm

Northeast Ohio Medical University College of Pharmacy, Rootstown, Ohio

Submitted January 15, 2015; accepted April 15, 2015; published August 25, 2015.

Objective. To develop, implement, and modify a required, second-year pharmacy course that provides an understanding of the scientific, therapeutic, and clinical principles, as well as the evidence-based medicine underlying the use of natural products.

Design. A 28-hour, multi-faculty course was developed and offered in 2008. The course was modified over the years to enhance students' practice skills in the use of natural products. A course evaluation and survey were administered to assess the students' opinions.

Assessment. Students performed well in the course and provided favorable evaluations, especially for the latest offering. Students reported significantly improved skills in providing advice to patients regarding the use of natural products.

Conclusion. The course increased the students' knowledge and application of information and counseling skills regarding natural products.

Keywords: course curriculum, dietary supplements, evidence-based medicine, herbal products, nutraceuticals

INTRODUCTION

The use of nonprescription products such as dietary supplements, herbal supplements, vitamins, minerals, and nutraceuticals (collectively known as "natural products") is increasing in the United States and in other developed countries.¹⁻³ Use of natural products is more common among whites, women, seniors, and those with a higher socio-economic status. Natural products also are used by patients who have serious chronic ailments, such as cancer, metabolic disorders, and neurodegenerative diseases.⁴ About 1 in 3 Americans routinely use natural products without reporting to or consulting their primary-care physicians.⁵ The unregulated use of natural products, which results in billions of dollars in annual sales, can pose a considerable risk to patient health.⁵ Because of their role in health care and accessibility to patients, pharmacists play a fundamental role in providing advice to ensure safe and effective use of self-care products. To help patients determine whether self-care with nonprescription products or consultation with a health-care provider is necessary, pharmacists need to be proficient in self-care counseling skills.⁶⁻⁹ Thus, pharmacy students

need evidence-based training in self-care. The Accreditation Council for Pharmacy Education (ACPE) Standards and Guidelines for the Professional Program in Pharmacy Leading to the Doctor of Pharmacy Degree recommend pharmacy students be provided instruction in the use of nonprescription self-care products.¹⁰ About 80% of pharmacy schools in the United States offer instruction in complementary and alternative medicine (CAM), which mostly focuses on self-care use of natural products.¹¹

The use of natural products is an important component of CAM and has emerged as a popular means of self-care.¹²⁻¹⁴ The American College of Clinical Pharmacy published a white paper on the use of natural products in the United States. The paper noted that although pharmacists are participants in the self-care of patients who are taking an increasing number of natural products, most pharmacists are not adequately educated about natural products and other types of CAM. Thus, the white paper recommended to make natural products an integral part of the pharmacy curriculum.¹⁵ More than a decade ago, the National Center for Complementary and Alternative Medicine at the National Institutes of Health funded an initiative called the CAM Education Project to incorporate CAM into the curriculum of conventional health professions schools.¹⁶⁻¹⁸ Since then, instruction in CAM and self-care—specifically, the use of natural products—rose

Corresponding Author: Altaf S. Darvesh, PhD, M.Pharm, Department of Pharmaceutical Sciences College of Pharmacy, Northeast Ohio Medical University, 4209, State Route 44, Rootstown, OH 44272. Tel: 330-325-6658. Fax: 330-325-5936. E-mail: adarvesh@neomed.edu

steadily and became an integral part of the curriculum at many colleges of pharmacy.¹⁹⁻²⁵

During the fall semester of the first year, pharmacy students at the Northeast Ohio Medical University College of Pharmacy are instructed on nonprescription products and self-care, which is their first exposure to this concept and its content. However, little time is dedicated to natural products. To fulfill the objective of providing more focused and effective instruction in the use of natural products, we developed and implemented a required course for second-year pharmacy students in the fall semester. The Natural Products and Nutraceuticals course is team-taught and provides an understanding of basic scientific, therapeutic, and clinical principles as well as the evidence-based medicine underlying the use of natural products, including their efficacy, adverse effects, and drug interactions. In this article, we describe the development and evolution of this course and its objectives which, in its latest form, was well-received and popular with students, who commented on its usefulness in counseling patients during site visits. Also highlighted in the article are teaching methods and techniques employed over the years, lecture topics, content, and student evaluations of the course and its objectives.

DESIGN

A 28-hour required course, Natural Products and Nutraceuticals, was offered for the first time in fall 2008 to second-year pharmacy students. The 2-hour course was taught twice a week for 7 weeks. It was designed to develop students' self-care skills and increase their familiarity with natural products. The syllabus and schedule were approved by the college's curriculum committee. In its initial years, course faculty members, some with degrees in pharmacy, were from the Department of Pharmaceutical Sciences. Course objectives (Appendix 1, 1-10), ability-based outcomes (ABOs, Appendix 1), and the course schedule (Table 1) were designed for the inaugural class. Each session was delivered in a traditional didactic PowerPoint lecture format. For the "Herb Garden" session (week 3), students had classroom instruction for 30 minutes, followed by a visit to the campus herb garden.

The course was modified over 7 years based primarily on student and faculty feedback. For the final lecture in 2009, a pharmacy practice faculty member, who was a clinical pharmacist, discussed clinical case studies that involved the integration of natural products into the case studies. In 2010, the university reference librarian delivered a lecture, "Herbal Resources," in the first week so that students would be familiar with resources to access accurate and unbiased information regarding natural products. In 2013, the course underwent major modification;

Table 1. Schedule for the Natural Products and Nutraceuticals Course Offered in Fall 2008

Week	Lecture Topics
1	Introduction (1 hour) Rules and Regulations (1 hour) Basic Plant Biology (1 hour) Natural Product Chemistry I (1 hour)
2	Natural Product Chemistry II (1 hour) Production, Standardization, and Quality Control (1 hour) Traditional Systems of Herbal Medicine (2 hours)
3	QUIZ 1 (1 hour) The Herb Garden (1 hour) Anticancer Drugs (2 hours)
4	The Gastrointestinal and Biliary System (2 hours) The Cardiovascular System (1 hour) The Respiratory System (1 hour)
5	The Central Nervous System (2 hours) QUIZ 2 (1 hour) The Infectious Diseases (1 hour)
6	The Endocrine, Reproductive Systems, and Urinary Tracts (2 hours) The Musculoskeletal System and the Skin (1 hour) The Eye, Ear, Nose, and Throat (EENT) (1 hour)
7	Vitamins and Supplements (2 hours) FINAL EXAMINATION (2 hours)

two practicing pharmacists were added to significantly enhance the clinical direction of the course (Table 2). Two course objectives also were added (Appendix A, 11, 12). The course was taught for 3 hours once a week for 9 weeks. For the first week, the "Introduction" lecture was expanded to 2 hours, with a "Rules and "Regulations" lecture being absorbed into in this lecture followed by the Herbal Resources lecture.

In the second week, basic plant biology, standardization, and quality-control lectures were combined for a single session – "Pharmacognosy." At the end of the lecture, students visited the campus herb garden. In the third week, the CAM lecture—which, until this point, was a 2-hour didactic lecture—was expanded into a 3-hour interactive session jointly conducted by a pharmaceutical sciences faculty member and a community pharmacist with more than 2 decades' experience in practicing herbal pharmacy and CAM.

The "Vitamins and Supplements" lecture in week 4 remained unchanged. For the next 2 weeks, students were introduced to several commonly used natural products, with evidence-based medicine being strongly emphasized in weeks 5 and 6. These classes offered the students a detailed review of core product knowledge, product familiarity, and skill development so they could complete clinical case studies under supervision of a pharmacy

Table 2. Schedule for the Natural Products and Nutraceuticals Course Offered in Fall 2013

Week	Lecture Topics
1	Introduction (2 hours) Herbal Resources (1 hour)
2	Pharmacognosy (3 hours)
3	Complementary and Alternative Medicine (3 hours)
4	QUIZ I (1 hour) Vitamins and Supplements (2 hours)
5	Organ Systems I (3 hours) The Gastrointestinal and Biliary System The Central Nervous System The Cardiovascular System
6	Organ systems II (3 hours) The Respiratory System The Reproductive System The Infectious Diseases Musculoskeletal System, Skin, Eye, Ear, Nose, and Throat (EENT)
7	QUIZ II (1 hour) Clinical Case Studies (2 hours)
8	Merchandising Nonprescription and Herbal/Natural Products: Site visit to a local retailer (3 hours)
9	FINAL EXAMINATION (2 hours)

practice faculty member and have a productive site visit to a local pharmacy. The penultimate session in week 7 was used to review case studies, with students working in groups of 5 or 6. The final session in week 8, which was conducted by another pharmacy practice faculty member, involved a student visit to a local grocery store pharmacy to provide on-site instruction on merchandising natural products. The course schedule adopted in 2013 was also repeated in fall 2014.

The course faculty members ensured course objectives (Appendix 1) were covered in the schedule during the weekly sessions when the course was modified in 2013 (Table 2). Because the first objective represents the overarching theme of the course, it was emphasized throughout the course but was taught primarily in the “Introduction” lecture (week 1). Objective 4 also was taught in the

“Introduction” lecture. Objectives 2, 3, 5, 6, and 7 were taught in the “Pharmacognosy” lecture (week 2). The CAM session (week 3) covered objective 8. Weeks 4, 5, and 6 were dedicated to meeting objectives 9 and 10. The clinical case studies session in week 7 was used for objective 11. The site visit to a local pharmacy conducted in week 8 met the final objective (12) of the course.

EVALUATION AND ASSESSMENT

Course grading was divided between 2 quizzes (25% each of the final grade) and the cumulative final examination (50% of the final grade). Based on the total score, students received a course grade [Honors ($\geq 90\%$); Pass ($\geq 70\%$); Fail ($< 70\%$)] (Table 3). Students have performed well in the course since the beginning of the course in 2008, and the average scores have remained steady over the years. The courses offered in after revision 2013 and 2014 saw a significant increase in the number of students receiving the honors grade. At the end of the course, students completed a course evaluation. A 4-point Likert scale was used to assess student responses (1=strongly agree; 2=agree; 3=disagree; 4=strongly disagree) for each evaluation statement (Table 4). Students also provided written comments at the time of the course evaluation. Student responses to the usefulness of course objectives show a steady improvement over the years. Students’ scores showed improvement in their knowledge of natural products, their ability to evaluate scientific literature, identify drug-food and drug-herb interactions and guide self-medication in a community setting. Beginning in 2009 and continuing until 2014, a student survey was conducted to evaluate students’ perspective on their ability to perform the skills described in the ABOs of the course. The survey questionnaire was approved by the University Institutional Review Board. Students were asked to assess their ability to perform several pharmacist duties prior to and upon completing the course. A 4-point Likert scale also was used to assess student survey results for each evaluation statement (Table 5). Student survey scores show a steady

Table 3. Grades and Scores Obtained by Students in the Natural Products and Nutraceuticals Course

Year	No. Students	Honors ($\geq 90\%$)	Pass ($\geq 70\%$)	Fail ($< 70\%$)	Maximum Score (%)	Minimum Score (%)	Average Score (SD) (%)
2008	63	5	57	1	95	68	84 (6)
2009	69	5	63	1	93	66	83 (6)
2010	72	6	66	0	98	76	86 (5)
2011	63	5	57	1	97	68	82 (5)
2012	60	9	50	1	97	67	84 (6)
2013	67	16	51	0	97	75	85 (5)
2014	81	21	60	0	96	75	87 (4)

Table 4. Students' Responses to Course Objectives and Their Usefulness

Statement	Average Score (SD)						
	2008	2009	2010	2011	2012	2013	2014
Your knowledge of natural products, nutraceuticals, and supplements prior to this course	3.5 (0.6)	3.6 (0.5)	3.4 (0.8)	3.0 (1.0)	3.1 (1.0)	2.9 (1.1)	2.8 (1.1)
Your knowledge of natural products, nutraceuticals, and supplements upon completing this course	2.2 (0.5)	2.0 (0.5)	1.9 (0.7)	1.8 (0.5)	1.8 (0.6)	1.6 (0.5)	1.5 (0.5)
Your ability to evaluate scientific literature to guide the use of natural products, nutraceuticals, and supplements	2.3 (0.6)	2.1 (0.7)	2.0 (0.8)	2.0 (0.6)	1.9 (0.8)	1.9 (0.7)	1.5 (0.7)
Your ability to identify drug and food interactions associated with natural products, nutraceuticals, and supplements	2.5 (0.5)	2.3 (0.6)	2.0 (0.7)	1.9 (0.6)	1.8 (0.7)	1.9 (0.7)	1.6 (0.7)
Your ability to guide self-medication in the community setting	2.2 (0.4)	1.9 (0.5)	1.6 (0.6)	1.6 (0.5)	1.6 (0.6)	1.5 (0.5)	1.3 (1.4)
Overall the course met the objectives stated in the syllabus.	2.0 (0.9)	1.5 (0.6)	1.2 (0.4)	1.3 (0.4)	1.2 (0.5)	1.2 (0.4)	1.1 (0.3)
Number of student respondents	44 (70%)	67 (97%)	70 (97%)	62 (98%)	58 (97%)	66 (98%)	80 (99%)

1=strongly agree, 2=agree, 3=disagree, 4=strongly disagree

improvement over the years. This demonstrates increased student ability to perform several ABO-related tasks such as correct stocking and selection of natural products along with effective counseling and advice on potential drug-herb contraindications.

DISCUSSION

Students performed well in the course and had a favorable opinion about it. However, based on student comments in 2008, the course did not significantly address teaching the use of natural products in a clinical setting. Students' written comments suggested that they did not feel adequately prepared in recommending natural products to patients during their pharmacy career. Thus, in 2009, a pharmacy practice faculty member reviewed clinical case studies that involved the use of natural products at the end of the course. This remained one of the most popular sessions in the course, based on students' comments, such as: "The clinical lecture really helped me put into perspective on how everything that I learned in the course could be applied in counseling patients in the pharmacy," and, "The clinical session was extremely helpful and has given me tremendous confidence in advising patients."

The ability to quickly access accurate information about natural products is important for pharmacists if they

are to provide good advice on the use of such products. Patients can find information about natural products from sources such as print media, the Internet, and information provided with nonprescription natural products. Studies show that key safety information is often not provided, which may result in adverse effects and cause drug-herb interactions.²⁶⁻²⁸ Course faculty members as well as students opined that the course should more thoroughly teach students how to access accurate information about herbal products. To rectify this gap, in 2010, the university reference librarian spent an hour in the first week reviewing resources from which to access natural product information. This was well-received by students as evident from oral and written comments.

Although students' results were excellent (Table 3) since the course was first offered the course was modified and overhauled in 2013 to condense its basic science component, while enhancing its clinical and practice aspects. This decision was based primarily on comments made by third-year and fourth-year students, as well as the course faculty members. These changes were approved by the college's curriculum committee. In the revised version, the course was offered once a week, with every week's session having a particular theme to provide a more focused presentation of the topics. The weekly

Table 5. Survey Results on Course Ability-based Outcomes (ABOs)

Statement	Average Score (SD) Precourse/Postcourse					
	2009	2010	2011	2012	2013	2014
Determining the proper natural products, nutraceuticals, and supplements to stock in your pharmacy	3.3 (0.6) 2.1 (0.5)	3.2 (0.9) 1.9 (0.7)	2.9 (1.0) 1.9 (0.6)	2.8 (1.1) 1.8 (0.7)	2.8 (1.1) 1.7 (0.7)	2.8 (1.2) 1.6 (0.6)
Selecting the most appropriate natural product, nutraceutical, and supplement for a patient	3.6 (0.5) 2.1 (0.5)	3.3 (0.9) 1.9 (0.6)	3.0 (1.0) 1.9 (0.5)	2.8 (1.0) 1.9 (0.7)	2.8 (1.0) 1.7 (0.6)	2.8 (1.2) 1.6 (0.6)
Counseling a patient on the use of a specific natural product, nutraceutical, and supplement	3.6 (0.5) 2.2 (0.6)	3.4 (0.9) 1.9 (0.6)	2.8 (1.0) 1.9 (0.5)	2.8 (1.1) 1.8 (0.7)	2.9 (1.0) 1.7 (0.7)	2.8 (1.2) 1.5 (0.6)
Providing effective arguments when natural products, nutraceuticals, and supplements are contraindicated	3.6 (0.5) 2.2 (0.5)	3.3 (0.9) 1.9 (0.7)	2.9 (1.0) 1.8 (0.6)	2.8 (1.1) 1.8 (0.7)	2.8 (1.1) 1.7 (0.6)	2.8 (1.1) 1.5 (0.6)
Number of student respondents	67 (97%)	70 (97%)	62 (98%)	58 (97%)	66 (98%)	80 (99%)

1 =strongly agree, 2 =agree, 3 =disagree, 4 =strongly disagree

thematic sessions were well-received by the students and course faculty members. During the course, samples of natural products were circulated among students to examine, and students found this instructive as well.

Student attitudes toward CAM and the use of natural products are investigated in the literature. Although the overall attitude seems positive, a major reason for skepticism is the lack of evidence supporting the efficacy of natural products,²⁹⁻³² a perspective reinforced among students in this course, especially in the first weeks. Beginning in 2013, considerable time was devoted to discussing this matter with students during the 2-hour introduction lecture. The interactive CAM session in week 3 was also well-received by students and was key to improving their understanding of various CAM practices as shown by student comments, such as: “The CAM session was very interesting! I think this was an important section to cover as well. It gives the pharmacist a better perspective to the types of ‘healing’ people can try to make themselves better,” and “The CAM pharmacist was very informative and gave some real-world stories related to homeopathy, naturopathy and other CAM practices.”

Based on feedback from third-year and fourth-year students who had taken the course, we decided students would benefit from visiting a pharmacy to study natural product merchandising. This off-campus course activity, both novel and innovative, was facilitated by a pharmacy practice faculty member who worked at the pharmacy, and it proved useful to the students’ ability to effectively counsel patients. A major onsite activity was a scavenger hunt along with a review of the setup of natural products in the nonprescription section of the store. Student

comments noted the usefulness of seeing the setup of natural products at a site, that information provided at the grocery pharmacy was helpful and helped them learn key points in selling herbals and counseling patients on nonprescription products at a store, and that the store visit at the end of the course helped teach how to apply all the information learned in lectures.

The modified course offered in 2013 – proved popular with students, and was repeated in 2014 with similar success. Survey studies have been useful in evaluating the pharmacists’ and pharmacy students’ knowledge of and counseling skills for natural products.³³⁻³⁶ The student survey evaluating their ability to perform tasks related to the course ABOs was useful in evaluating the effectiveness of the course modifications. Survey results demonstrated improved confidence levels in the execution of the ABOs after completion of the course. This is evident from the 2013 and 2014 survey scores seen in Table 5. Student written and verbal feedback–also proved valuable in deciding on course modifications.

Course evaluation scores listed in Table 4 highlight the gradual improvement of scores over the years, which were in line with modifications that the course underwent in that period. Student scores showed improvement in their knowledge of natural products, their ability to evaluate scientific literature and identify drug-food and drug-herb interactions and guide self-medication in a community setting. Table 5 shows marked improvement in student survey scores, highlighting their ability to perform several ABO-related tasks in the pharmacy, such as determining the correct products to stock and select for patients, as well as

provide effective counseling, including advice on potential drug-herb contraindications.

The evolution of this course, from a basic science course (similar to a traditional pharmacognosy and natural product chemistry course) to a course that teaches self-care, patient assessment, and counseling skills to pharmacy students continues to be evaluated. In the future, we plan to assess the impact of the course content on educating and training pharmacy students in the proper use of and counseling about natural products. We will conduct a survey of third-year and fourth-year pharmacy students who took the course in their second year, as well as their preceptors, to assess student performance on the course ABOs. Additional course modifications will be based partly on survey results. Clinical faculty members, preceptor, and student attitudes on CAM and natural products will be assessed. The feasibility of providing a CAM certificate course to pharmacy students, preceptors, and pharmacists is also being evaluated.

SUMMARY

The Natural Products and Nutraceuticals course is an integral part of the pharmacy curriculum. The course is important in training students in self-care skills for nonprescription natural products. The course syllabus is routinely evaluated and modified based on student, faculty, and preceptor feedback. The course in its current version remains popular with students and is effective in enhancing their knowledge of natural products, and their patient-counseling skills. We continue to evaluate the effectiveness of the course-outcome measures and to provide changes and modifications to improve instruction on natural-products to pharmacy students.

REFERENCES

1. Moquin B, Blackman MR, Mitty E, Flores S. Complementary and alternative medicine (CAM). *Geriatr Nurs*. 2009;30(3):196-203.
2. Chauhan B, Kumar G, Kalam N, Ansari SH. Current concepts and prospects of herbal nutraceutical: a review. *J Adv Pharm Technol Res*. 2013;4(1):4-8.
3. McFarland B, Bigelow D, Zani B, Newsom J, Kaplan M. Complementary and alternative medicine use in Canada and the United States. *Am J Public Health*. 2002;92(10):1616-1618.
4. Rock CL. Multivitamin-multimineral supplements: who uses them? *Am J Clin Nutr*. 2007;85(1):277S-279S.
5. Bonafede M, Caron W, Zeolla M. An evidence-based elective on dietary supplements. *Am J Pharm Educ*. 2009;73(5):Article 80.
6. Kemper KJ, Gardiner P, Gobble J, Woods C. Expertise about herbs and dietary supplements among diverse health professionals. *BMC Complement Altern Med*. 2006;6:15.
7. Kwan D, Hirschhorn K, Boon H. U.S. and Canadian pharmacists' attitudes, knowledge, and professional practice behaviors toward dietary supplements: a systematic review. *BMC Complement Altern Med*. 2006;6:31.
8. Howard N, Tsourounis C, Kapusnik-Uner J. Dietary supplement survey of pharmacists: personal and professional practices. *J Altern Complement Med*. 2001;7(6):667-680.
9. Kemper KJ, Amata-Kynvi A, Dvorkin L, et al. Herbs and other dietary supplements: healthcare professionals' knowledge, attitudes, and practices. *Altern Ther Health Med*. 2003;9(3):42-49.
10. Accreditation Council for Pharmacy Education. Accreditation standards and guidelines for the professional program in pharmacy leading to the doctor of pharmacy degree. Chicago, IL, 2011.
11. Dutta AP, Daftary MN, Egba PA, Kang H. State of CAM education in U.S. schools of pharmacy: results of a national survey. *J Am Pharm Assoc (Wash)*. 2003;43(1):81-83.
12. Eisenberg DM, Davis RB, Ettner SL, et al. Trends in alternative medicine use in the United States, 1990-1997. Results of a follow-up national survey. *JAMA*. 1998;280(18):1569-1575.
13. Johnston BA. One-third of nation's adults use herbal remedies: market estimated at \$3.24 billion. *HerbalGram*. 1997;40:49.
14. Bailey RL, Garcke JJ, Lentino CV, et al. Dietary supplement use in the United States, 2003-2006. *J Nutr*. 2011;141(2):261-266.
15. Miller LG, Hume A, Harris IM, et al. ACCP White Paper on herbal products. *Pharmacotherapy*. 2000;20(7):877-891.
16. Nedrow AR, Istvan J, Haas M, et al. Implications for education in complementary and alternative medicine: a survey of entry attitudes in students at five health professional schools. *J Altern Complement Med*. 2007;13(3):381-386.
17. Lee MY, Benn R, Wimsatt L, et al. Integrating complementary and alternative medicine instruction into health professions education: organizational and instructional strategies. *Acad Med*. 2007;82(10):939-945.
18. Pearson NJ, Chesney MA. The CAM education program of the National center for complementary and alternative medicine: an overview. *Acad Med*. 2007;82(10):921-926.
19. Steinfeldt L, Hughes J. An evidence-based course in complementary medicines. *Am J Pharm Educ*. 2012;76(10):Article 200.
20. Shah B, Siganga W, Mallya U, Shah S. Pharmacy student perspectives on classroom education about herbal supplements. *Am J Pharm Educ*. 2005;69(5):Article 102.
21. Islam MA. An elective course on the basic and clinical sciences aspects of vitamins and minerals. *Am J Pharm Educ*. 2013;77(1):Article 17.
22. Frenzel JE, Skoy ET, Eukel HN. Design and evaluation of a self-care educational activity as a student learning experience. *Am J Pharm Educ*. 2014;78(1):Article 12.
23. Sulli MM, Whetsel T. Teaching self-care as a junior faculty member: perspectives and lessons learned. *Am J Pharm Educ*. 2006;70(6):Article 142.
24. Krypel LL. Constructing a self-care curriculum. *Am J Pharm Educ*. 2006;70(6):Article 140.
25. Hamilton WR, Padron VA. Instilling practical knowledge about nonprescription product use. *Am J Pharm Educ*. 2005;69(5):Article 84.
26. Owens C, Baergen R, Puckett D. Online sources of herbal product information. *Am J Med*. 2014;127(2):109-115.
27. Morris CA, Avorn J. Internet marketing of herbal products. *JAMA*. 2003;290(11):1505-1509.
28. Raynor DK, Dickinson R, Knapp P, Long AF, Nicolson DJ. Buyer beware? Does the information provided with herbal products available over the counter enable safe use? *BMC Med*. 2011;9:94.
29. Atayee RS, Singh, RF, Best BM, Freedman BA, Morello CM. An active-learning assignment peer-to-peer presentations to improve pharmacy students' attitudes and knowledge of dietary supplements. *Am J Pharm Educ*. 2012;76(6):Article 113.

30. Hussain S, Malik F, Hameed A, et al. Pakistani pharmacy students' perception about complementary and alternative medicine. *Am J Pharm Educ.* 2012;76(2):Article 21.
31. Tiralongo E, Wallis M. Attitudes and perceptions of Australian pharmacy students towards Complementary and Alternative Medicine – a pilot study. *BMC Complement Altern Med.* 2008;8:2.
32. Harris IM, Kingston RL, Rodriguez R, Choudary V. Attitudes towards complementary and alternative medicine among pharmacy faculty and students. *Am J Pharm Educ.* 2006;70(6):Article 129.
33. Lin HW, Pickard AS, Mahady GB, Karabatsos G, Crawford SY, Popovich NG. An instrument to evaluate pharmacists' patient counseling on herbal and dietary supplements. *Am J Pharm Educ.* 2010;74(10):Article 192.
34. Lin HW, Pickard AS, Mahady GB, Popovich NG. Conceptual development of a measure to assess pharmacists' knowledge of herbal and dietary supplements. *Am J Pharm Educ.* 2008;72(3):Article 59.
35. Clauson KA, McQueen CE, Sheilds KM, Bryant PJ. Knowledge and attitudes of pharmacists in Missouri regarding natural products. *Am J Pharm Educ.* 2003;67(2):Article 41.
36. Johnson T, Boon H, Jurgens T, et al. Canadian pharmacy students' knowledge of herbal medicine. *Am J Pharm Educ.* 2008; 72(4):Article 75.

Appendix 1.

Objectives and Ability-based Outcomes (ABOs) for the Natural Products and Nutraceuticals Course

Objectives

1. Understand the basic scientific, therapeutic, and clinical principles, as well as the “evidence-based medicine” underlying the rational use of medicinal plants, herbal medications, natural products, phytomedicines, vitamins, minerals, supplements, and nutraceuticals.
2. Understand the basic principles of pharmacognosy and phytotherapy.
3. Review the importance of plants in modern pharmacy and medicine.
4. Review the legal, professional, and regulatory issues associated with the use of natural products and nutraceuticals.
5. Understand the general principles of basic plant biology, natural product chemistry, and isolation of phytochemicals.
6. Review the processes involved in the production, standardization, and quality control of natural products.
7. Discuss in detail the selected monographs of natural products and herbal medications from the United States Pharmacopoeia–National Formulary.
8. Understand the various traditional systems of herbal and alternative medicine.
9. Review the natural products, phytomedicines, supplements, and nutraceuticals used in various therapeutic areas.
10. Discuss in detail select important herbal medications describing their history, source, chemical constituents, pharmacology, purported therapeutic use, efficacy, toxicity, adverse effects, and drug interactions.
11. Solve clinical case studies involving the use of natural products in the treatment of several diseases.
12. Describe a process for assessing whether or not an individual is a candidate for a natural product, and if selecting a product to recommend, define the key counseling points for that specific product.

ABOs

At the conclusion of the course, the students will be able to perform the following ABOs:

1. Determine the legitimate use of a natural product.
2. Advise and counsel a patient on the proper use, possible side effects, and herb-drug interactions of natural products, nutraceuticals, vitamins, minerals, and supplements.
3. Stock the most effective, safe, and elegant natural products, nutraceuticals, and supplements in the pharmacy, especially in the nonprescription section.
4. Assess any possible natural product medication history of the patient.
5. Advise and counsel a patient on choosing the most safe and effective natural products.
6. Identify the most appropriate dosage forms of a natural product for a patient.