



Ginkgo Biloba



Echinacea

# Getting to The Roots of It!

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St. John's Wort



Valerian Root



## ABSTRACT

This project aimed to use DNA barcoding analysis to identify 4 different herbal supplements found in various shops throughout New York City: ginkgo biloba, valerian root, St. John's wort, and echinacea. By extracting DNA from each sample, the barcode portions of the rbcL gene were amplified using polymerase chain reaction (PCR). The amplified sequences were then sent for sequencing. The sequences were used to search the DNA database using the DNA Subway software to identify closest matches. The results that we obtained reflect the possible species present in their corresponding supplements.

## INTRODUCTION

New York City holds one of the largest Chinese populations in the United States of America. This vast population characterizes one of many factors that make New York City so unique. One influential factor is Chinese herbal medicine and its influence within the Chinese community and non-Chinese people alike. As herbal medicines and supplements begin to grow increasingly popular in treating numerous ailments, mislabeled products are also growing as common problems. The herbs that we studied are *valeriana officinalis* (valerian root), *echinacea purpurea* (echinacea), *hypericum perforatum* (St. John's wort), and *ginkgo biloba* (ginkgo biloba).

## MATERIALS AND METHODS

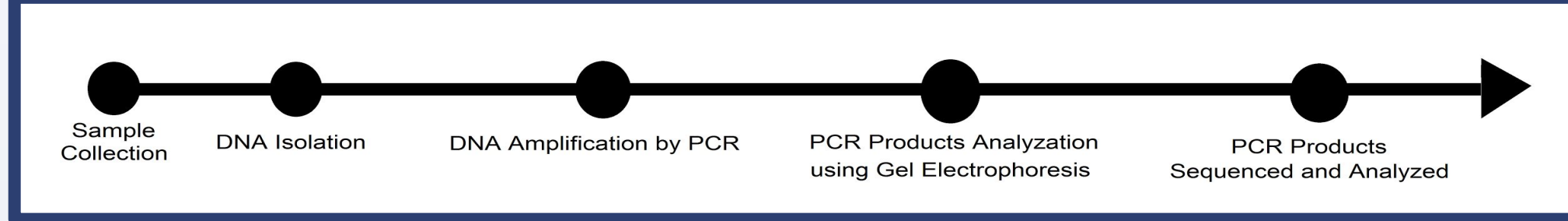


Figure 1: flow chart of methods

DNA was extracted from the samples and mixed with the plant primer specific to the rbcL gene, followed by amplification by PCR. Then gel electrophoresis was used to confirm the presence of the amplified DNA segments. The DNA was then sent to a commercial lab for sequencing. The results were analyzed using DNA Subway software and BLAST algorithm to match our sequenced DNA to species from the Unigene database.

## RESULTS AND DISCUSSION

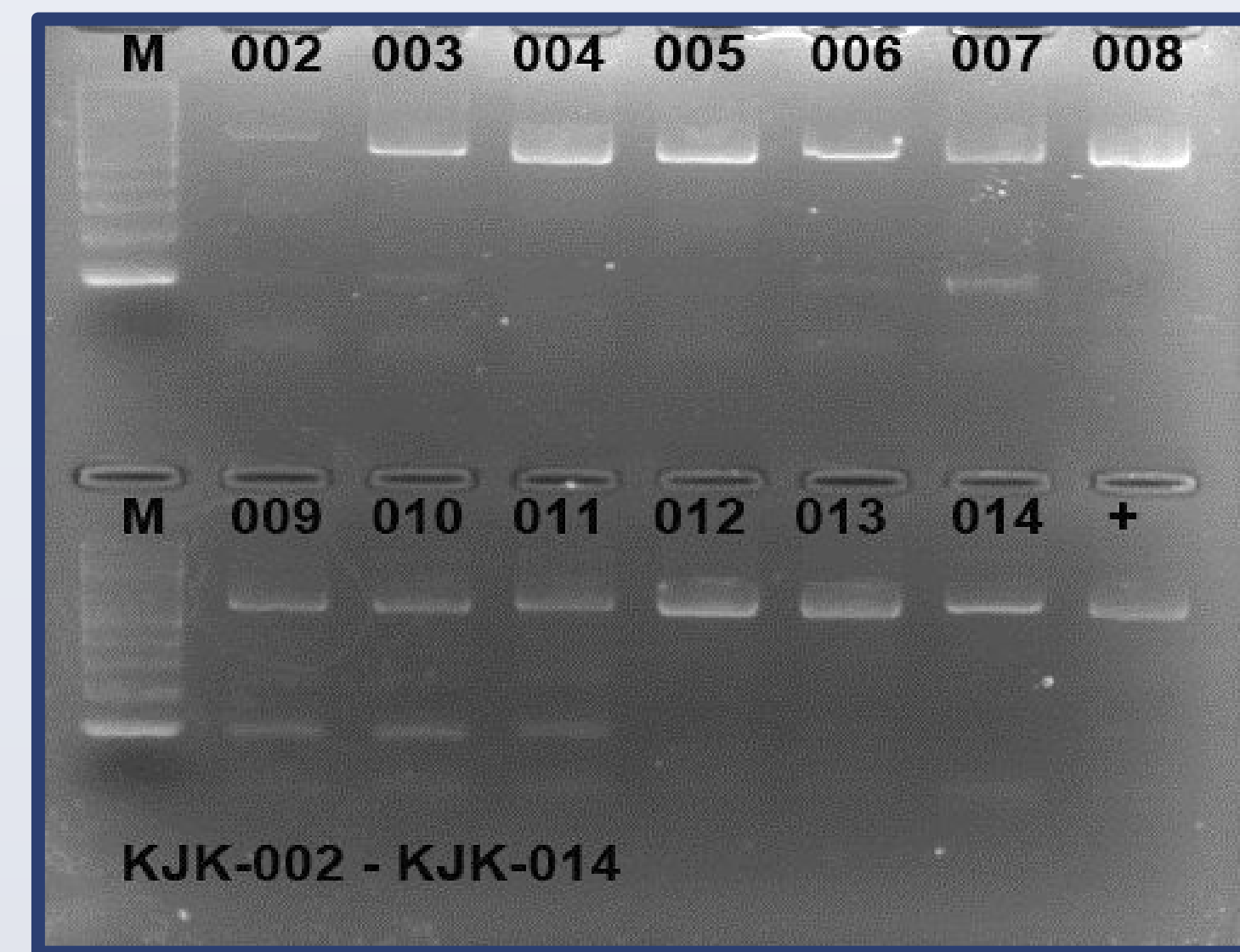


Figure 2: Electrophoresis gel Results

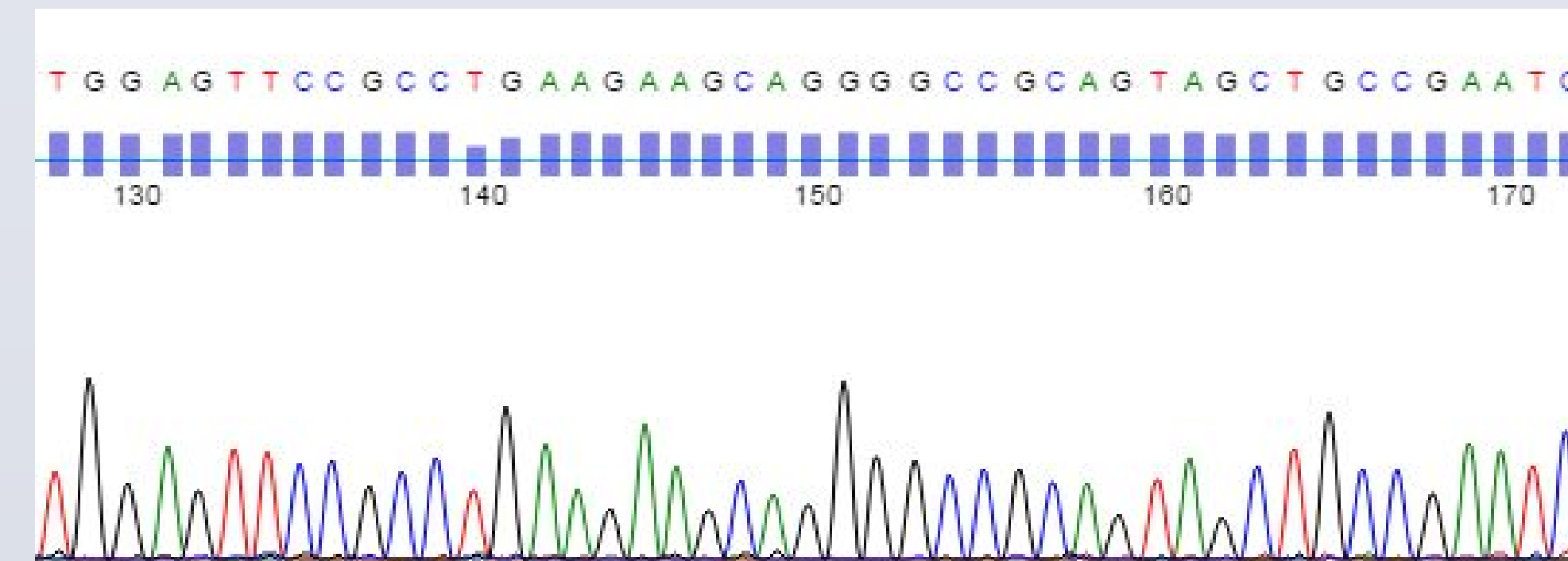


Figure 3: Ginkgo Biloba (KJK-004) sequence

Our Samples matches

### Valerian Root Samples

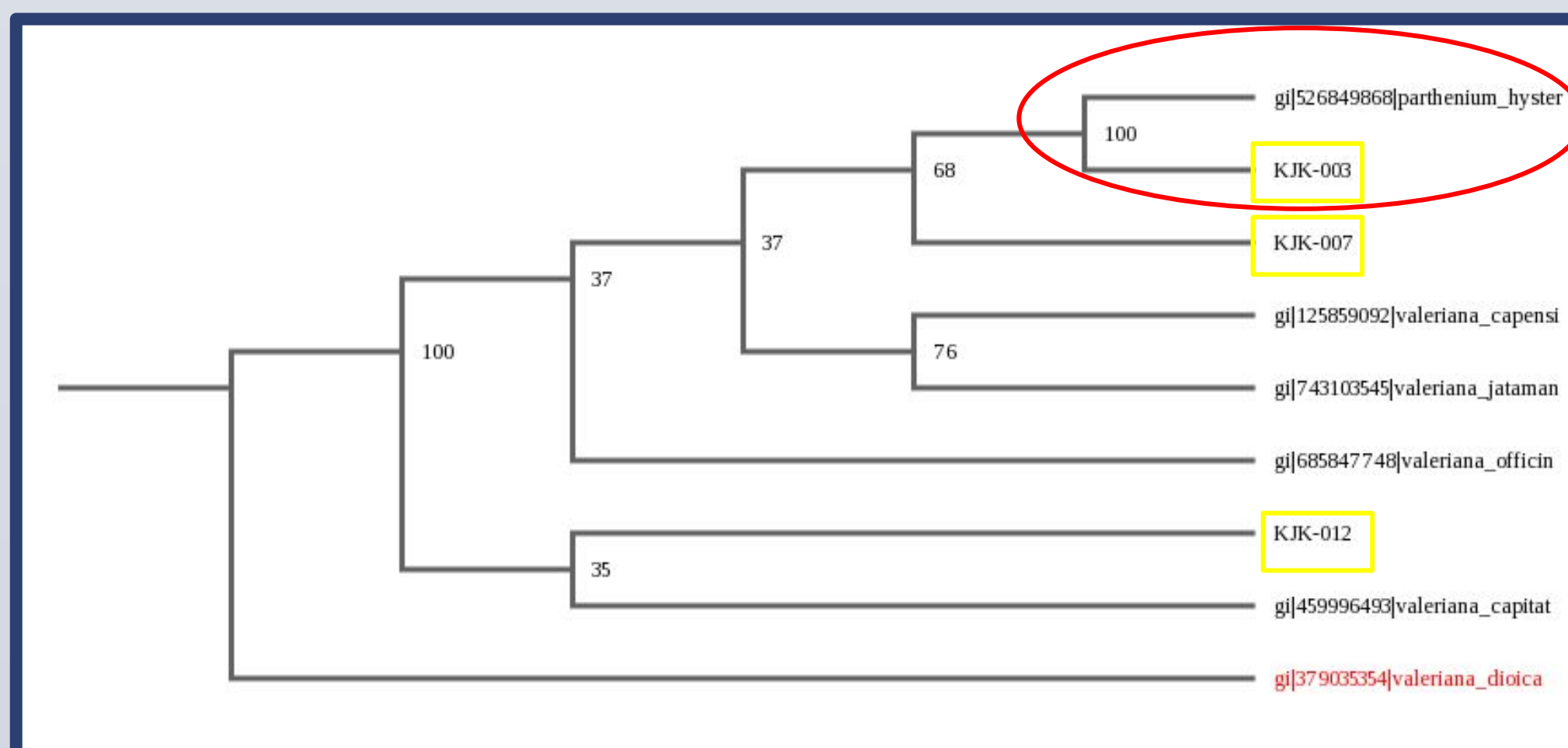


Figure 4.1: Phylogenetic tree for Valerian root samples

### Echinacea Samples

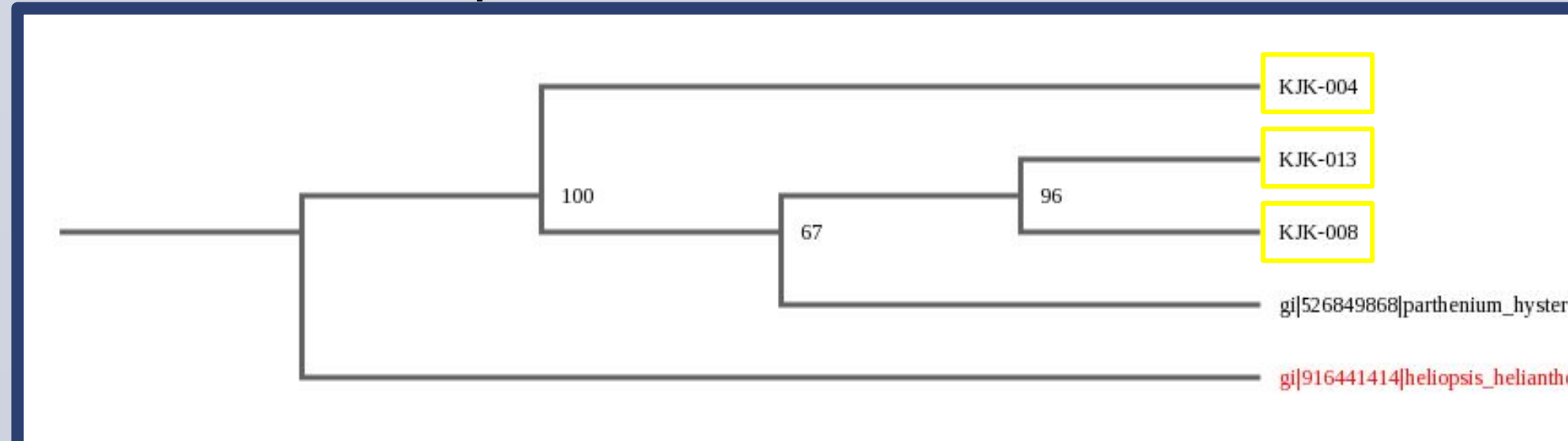


Figure 4.2: Phylogenetic tree for Echinacea samples

### St. John's Wort Samples

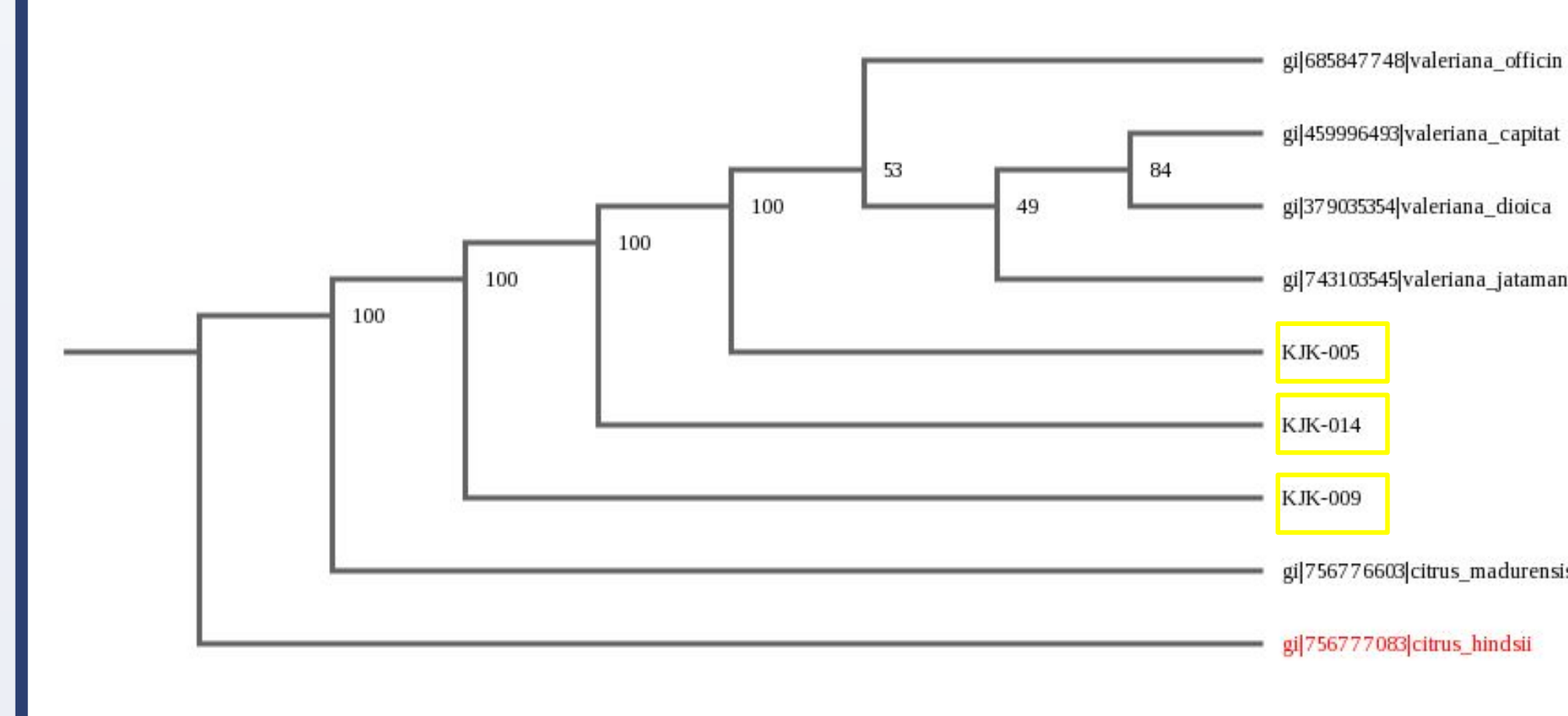


Figure 4.3: Phylogenetic tree for St. John's Wort samples

### Ginkgo Biloba Samples

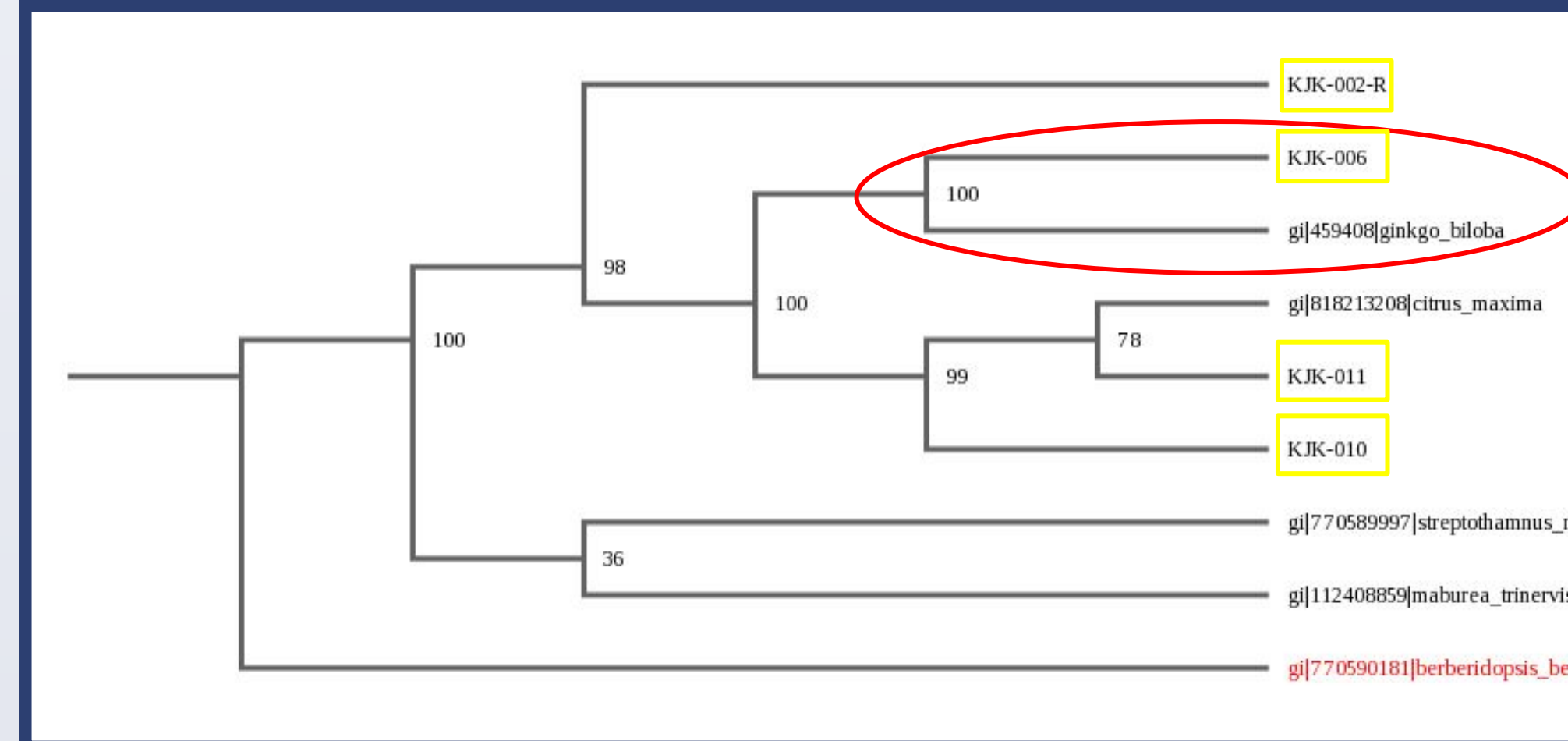


Figure 4.4: Phylogenetic tree for Ginkgo biloba samples

### Valeriana officinalis (Valerian root) matches

Store 1	Store 2	Store 3
<i>Parthenium hysterophorus</i> <ul style="list-style-type: none"><li>- Known to cause asthma, dermatitis, and bronchitis</li><li>- Contain toxins lethal to humans</li><li>- Used as flea-repellent</li></ul>	<i>Valeriana jatamansi</i> <ul style="list-style-type: none"><li>- Used for eye problems</li><li>- Heart and Liver</li><li>- Hysteria / nervous unrest</li><li>- Pain reliever</li><li>- Used to clear the voice</li></ul>	<i>Valeriana officinalis</i> <ul style="list-style-type: none"><li>- Insomnia</li><li>- Anxiety disorders</li></ul>
	<i>Valeriana capensis</i> <ul style="list-style-type: none"><li>- Used to treat epilepsy, hysteria, and nervous disorders in African traditional medicine</li></ul>	<i>Valeriana jatamansi</i>
	<i>Valeriana capitata</i> <ul style="list-style-type: none"><li>- Remedy for hysteria</li><li>- Insomnia</li><li>- Raw roots are considered poisonous</li><li>- Oil used to attract rats for traps</li><li>- Epilepsy</li></ul>	<i>Valeriana capensis</i>

Table 2.1: Valerian root matches and effects

### Echinacea purpurea (Echinacea) matches

Store 1	Store 2	Store 3
<i>Parthenium hysterophorus</i> <ul style="list-style-type: none"><li>- Known to cause asthma, dermatitis, and bronchitis</li><li>- Contain toxins lethal to humans</li><li>- Used as flea-repellent</li></ul>	<i>Parthenium hysterophorus</i>	<i>Parthenium hysterophorus</i>
<i>Heliopsis helianthoides</i> <ul style="list-style-type: none"><li>- Invasive species</li></ul>	<i>Heliopsis helianthoides</i>	<i>Heliopsis helianthoides</i>

Table 2.2: Echinacea matches and effects

### Hypericum perforatum (St. John's Wort) matches

Store 1	Store 2	Store 3
<i>Valeriana officinalis</i> <ul style="list-style-type: none"><li>- Insomnia</li><li>- Anxiety disorders</li></ul>	<i>Citrus madurensis</i> <ul style="list-style-type: none"><li>- Calamondin</li><li>- Has Chinese origin</li></ul>	<i>Hypericum perforatum</i> <ul style="list-style-type: none"><li>- Depression</li><li>- Inflammation (minor burns, wounds)</li><li>- Premenstrual syndrome</li><li>- Menopause</li></ul>
<i>Valeriana jatamansi</i>	<i>Citrus hindsii</i> <ul style="list-style-type: none"><li>- Kumquat</li><li>- improve immune system</li><li>- regulate digestive system</li></ul>	<i>Hypericum punctatum</i> <ul style="list-style-type: none"><li>- Contains more of the active ingredient, hypericin and related compounds</li></ul>
<i>Valeriana capitata</i>		<i>Hypericum undulatum</i>

Table 2.3: St. John's Wort matches and effects

### Ginkgo biloba (Ginkgo biloba) matches

Store 1	Store 2	Store 3	Store 4
<i>Maburea trinervis</i>	<i>Ginkgo biloba</i> <ul style="list-style-type: none"><li>- Memory (dementia and Alzheimer)</li><li>- Circulatory system</li><li>- Eye problems (glaucoma, macular degeneration)</li><li>- Sexual performance problems</li></ul>	<i>Citrus maxima</i> <ul style="list-style-type: none"><li>- Leaves, flowers, and rind: sedative effect</li><li>- Compulsive disorders (coughing)</li><li>- Peel- skin irritants, may cause dermatitis from excessive contact with outer peels' oil</li></ul>	<i>Citrus maxima</i>
<i>Streptothamnus moorei</i>		<i>Citrus reticulata</i> <ul style="list-style-type: none"><li>- Mandarin orange</li></ul>	<i>Citrus reticulata</i>
<i>Berberidopsis beckleri</i>		<i>Citrus sinensis</i> <ul style="list-style-type: none"><li>- Orange</li></ul>	<i>Citrus sinensis</i>

Table 2.4: Ginkgo biloba matches and effects

## CONCLUSION

Our analysis showed that about 70% of the samples collected were incorrectly labeled. Substitutes are often used when supply of the ingredient is low or too expensive. Our results indicate that certain substitutions can be harmful for consumption and raise suspicion on whether or not these labels can be trusted.

We identified our species using a primer that targets the rbcL gene, which is a chloroplast gene. Since a portion of our samples were roots, which contain little to no chloroplasts, it is very likely that we were unable to identify the exact species.

Regardless, the results obtained from this study bring attention to the need of more careful regulations on mislabeled herbal supplements and the substitutes used in their place.

## REFERENCES

Asian American Federation of New York Census Information Center. "Neighborhood Profile: Manhattan's Chinatown." *Neighborhood Profile: Manhattan's Chinatown* (n. d.). n. pag. Web. <<http://www.aafny.org/cic/briefs/Chinatownbrief.pdf>>.

Bent, Stephen. "Herbal Medicine in the United States: Review of Efficacy, Safety, and Regulation: Grand Rounds at University of California, San Francisco Medical Center." *Journal of General Internal Medicine* 23.6 (2008): 854-859. *PMC*. Web. 15 Oct. 2015.

Callaway, Ewen. "Screen Uncovers Hidden Ingredients of Chinese Medicine." *Nature.com*. Nature Publishing Group, 12 Apr. 2012. Web. 5 Oct. 2015. <<http://www.nature.com/news/screen-uncovers-hidden-ingredients-of-chinese-medicine-1.10430>>.

"Echinacea: Uses, Side Effects, Interactions and Warnings - WebMD." *WebMD*. WebMD, n.d. Web. 15 Oct. 2015. <<http://www.webmd.com/vitamins-supplements/ingredientmono-981-echinacea.aspx?activeingredientid=981&activeingredientname=echinacea>>.

"Ginkgo Biloba (maidenhair Tree)." *Ginkgo Biloba*. Royal Botanic Gardens, n.d. Web. 3 Oct. 2015. <<http://www.keew.org/science-conservation/plants-fungi/ginkgo-biloba>>.

Krüger, Åsa. "DNA-Barcoding identification of medicinal roots from Morocco." (2008).

O'Connor, Anahad. "Herbal Plus- GNC Distributed Herbal Dietary Supplements." *New York Attorney General Target Supplements at Major Retailers*. New York Times, 3 Feb. 2015. Web. 3 Oct. 2015. <[http://well.blogs.nytimes.com/2015/02/03/new-york-attorney-general-targets-supplements-at-major-retailers/?\\_r=0](http://well.blogs.nytimes.com/2015/02/03/new-york-attorney-general-targets-supplements-at-major-retailers/?_r=0)>.

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