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Utilizing the Nutritional Potential and Secondary Plant Compounds of Neglected Fruit Trees and Other Plant Species of the Walnut-Fruit Forests in Kyrgyzstan

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Abstract

Forests make significant contributions to safeguarding agricultural production, food security, and nutrition of rural and urban populations. The walnut-fruit forests in Kyrgyzstan constitute a unique resource in this regard and are of global importance as a biodiversity hotspot. However, current patterns of forest management are unsustainable, vast parts of the forests are overaged, and derived benefits are unequally distributed among local populations. Walnut (*Juglans regia* L.) kernels have traditionally been used for human diets and constitute an economically important product of these forests. Although the walnut value chain in Kyrgyzstan is of significant economic importance, the level of domestic processing is weak and locally manufactured outputs are of low quality. The SUSWALFOOD project (BMBF, funding code 01DK17016) aims at contributing to the development of nutritious food from neglected and underutilized plant species of the Kyrgyz walnut-fruit forests, thereby improving local food security, promoting sustainable forest management, and increasing local incomes.

Initial analyses have investigated timber growth of walnut trees and quality parameters of respective nuts from various parts of the forests. Regarding quality parameters, nut dimensions and weight, kernel weight, and rupture force were determined to result in a classification of the investigated trees. Results show that most trees are old and may, therefore, be anticipated to display declining walnut yields, underlining the need for forest rejuvenation. Timber and nut quality varied considerably across the study area. These results will facilitate the selection of superior trees for forest regeneration. Further work in this project aims to (a) analyze the nutritional composition and secondary plant compounds of other selected plant species of the walnut-fruit forests and their potential use in new food products; (b) further investigate the morphology, diversity, and plant-soil interaction of these species to determine their biological productivity and to support sustainable management and conservation efforts; and (c) examine the socioeconomic and gender-specific impacts of traditional and contemporary utilization including market chains and cost-benefit assessments at the household level.

Keywords: Bioeconomy, Central Asia, food security, forest-based rural development, fruit tree, nutrition, value chain

Introduction

The walnut-fruit forests in the south-west of Kyrgyzstan are well known as a hotspot for biodiversity and are considered a significant genetic pool of wild fruit tree species. The forests are located on the western and south-western slopes of the Fergana and Chatkal mountain ranges close to the Uzbek border, covering roughly 47,000 ha ranging from 800 to 2100 m above sea level (Hemery & Popov 1998; National Academy of Sciences of the Kyrgyz Republic 2009). Human influence on the forests is significant and poses many threats jeopardizing future production, local livelihoods, and biodiversity. The Kyrgyz government has imposed a strict logging ban since 2008 to stop uncontrolled illegal walnut burl and timber logging. This ban, however, has also been criticised as an obstacle to productive and sustainable forest management (Carter et al. 2010). Today, the walnut-fruit forests are entirely state-owned and managed by the forestry agency. The local population obtains access to the forests via annual renting contracts to prepare hay and collect harvest from the trees within the forest. The lease agreement can be elongated up to 49 years (Undeland 2011). Excessive walnut collection, firewood withdrawal, hay cutting, and cattle grazing impose enormous pressure on the system, harming the ability to rejuvenate (Orozumbekov et al., 2009).

Along with that, the walnut-fruit forests have a potential to deliver food products with a high nutritive value to the local population (Akimaliev et al. 2013; Zaurov et al. 2013). 8% of the population in the country were undernourished in 2011 (FAOSTAT 2015). 13% of the children below 5 years of age were reported to have Vitamin A deficiency (Stevens et al. 2015; IFPRI 2015). While the food consumption pattern in Kyrgyzstan has shifted towards bread and wheat products, fruit product use reaches only 23% of the recommended food consumption norms (FAO 2007). Consequently, there is great potential to develop the use of wild fruit trees and other currently neglected plants of the walnut-fruit forests of Kyrgyzstan for human nutrition. Towards this goal, the SUSWALFOOD project started in April 2017 and aims to address the following three perspectives:

1) Nutritional potential and secondary plant compounds of neglected plant species, and development of new food products particularly targeting vulnerable consumer groups like children and women;
2) Socio-economic aspects, such as economic, market, and value-chain analyses, as well as the role of gender in current and traditional utilization and processing of forest products;
3) Morphological diversity of the wild fruit species and plant-soil interactions, directed to better understanding productivity, facilitating the selection of mother trees and to support genetic diversity.

Materials and Methods

Initial analyses within the frame of the research project embraced a desk study and literature review on socio-economic aspects, as well as an investigation of tree and nut characteristics of productive walnut trees (so-called ‘plus-trees’) in autumn 2016. A total of 80 plus-trees has been investigated, 61 of which walnut samples were collected from. 25 nuts were collected per tree and subsequently analysed. We assessed GPS position and elevation of the trees, measured the size of the nuts in all three axial dimensions with a sliding calliper, and determined the walnut weights. The hardness of walnut shell was measured as rupture force with the help of a texture analyser (zwicki-Line Z1.0 TS; Zwick Roell Group, Ulm/ Germany). After cracking, kernel weights were determined and the presence of undesired deviations like damages by pathogens assessed. The kernel yield, as the ratio of kernel weight to total weight, was calculated for each nut. Walnut size, weight, and kernel yield were graded following the system of Mamadjanov (2006). Statistical analysis included t-tests, ANOVA, and Fisher’s LSD test using Microsoft Excel 2016 and R Studio, Version 1.0.136.

Results and Discussion

Literature review on the socio-economic aspects

The populations living close to the walnut-fruit forests have been depending on these resources in many ways for generations (Schmidt 2012). The political and economic transition of Kyrgyzstan during the early 1990s has dramatically affected their socio-economic wellbeing. While collectively owned agricultural lands were privatized during the land reform, forest communities did not obtain private ownership rights in the forest resources. The breakdown of the centralized forest management and subsidizing system forced the local families to increase the load on the available resources in order to ensure their subsistence (Undeland 2011). Table 1 compares the utilization, harvest amounts, and prices recorded for a number of wild fruits during Soviet times and more recently. Since independence, a higher load on the forest occurs in comparison to the Soviet times. While in particular walnuts and wild apples were intensively commercialized and collected by local people due to their high market value, other species like barberry, wild pear, wild cherry, etc. are much less important and limited to household use as a consequence of the lack of processing chains and low market demand (Bourne 2012; Hardy 2015).

Table 1. Changes in the use of the walnut-fruit forest products in Kyrgyzstan over time*

Species	Main use of wild fruits		Fresh harvest, kg/ha		Reported price, USD/kg	
	1963-1967[1]	2011-2015	1963-1967[1]	2011-2015	1963-1967[1*]	2011-2015
Walnut	Consumption	Export[2]	26	~100[2]	3.05	1.9[2]
Wild apple	Juices, processing	Dried and exported, few used for juices[3]	170	2600[3]	2.63	0.37[3]
Wild cherry/ cherry plum	Juices, processing	Household use, forage[4]	37	n/a	0.43	n/a
Pistachio/ Almonds	Consumption	n/a	8	n/a	0.62	n/a
Barberry	Juices, processing	Household use[4]	n/a	n/a	n/a	n/a
Wild pear	Consumption, juices, processing	Household use, forage[4]	n/a	n/a	n/a	n/a

** Recalculated based on PPP; n/a – no data*

Sources: 1: Valiev (1968); 2: Bourne (2012); 3: Agrolead (2016); 4: Hardy (2015)

Morphological diversity: improving tree selection for forest renewal

Rejuvenation of the walnut-fruit forest led by the local forestry agency turned out to be insufficient due to structural problems and a lack of seeding material. Plus-trees have been identified during Soviet times for forest rejuvenation; however, their selection lacked a coherent methodology. Traits of these plus-trees are, therefore, currently under investigation to support the selection of superior mother trees for future forest rejuvenation. So-called "tree passports" summarize main traits of the trees, like time of flowering and drought sensibility, also considering future challenges like climate change. The research objective of this study was to assess the walnut quality of plus-trees and investigate the relationship with the elevation of tree growth.

The majority of the investigated walnuts received poor grading in terms of size and walnut weight, while kernel yield was graded mostly as average. Trees with good results in all quality indices should be identified and recommended for selection. A significant variation among but also within trees in quality parameters was observed. Nuts of trees growing in lower elevation ranges tended to be larger in size and weight, while nuts of trees growing in higher elevations tended to be smaller, less heavy, and easier to crack. However, no clear correlation between elevation and quality parameters was observed in this study.

The poor performance of plus-trees in size and weight of walnuts shows that, selection of trees made during Soviet times was insufficient and emphasizes the need for a tree passport. Considerable variation in the investigated trees underlines the genetic biodiversity of *Juglans regia* L. within the region. Interestingly, the results for plus-trees in our research deviated from results reported by Mamadjanov (2006), who assessed characteristics of trees from local tree

nurseries and foreign walnut varieties. In contrast, we assessed characteristics of the trees within the forest. Hence, our findings reflect the distinct environmental conditions inside the forests, like competition for nutrients, light, and water. They are also an indication of declining tree productivity, keeping in mind that most stands are over-aged. While some studies established a link between growing elevation and secondary plant compounds influencing kernel colour, we did not find a clear relationship between nut properties and elevation. Even though we observed significant differences between elevation groups and performance in size, weight, and rupture force, intra-species variability turned out to be stronger than the elevation effect.

Error sources that may potentially have affected our results derive from nut collection. As an instance, to reach nuts, trees were shaken and nuts collected from the ground. As maturity of walnuts can vary among trees it is possible that not fully developed nuts went into the samples. Shape of the nuts potentially influences rupture force; and this variable does not necessarily indicate the effort needed to crack a nut. Further research should aim to investigate many other important trees and nut characteristics, e.g. varieties, kernel colour, shell thickness, extractability of the kernels, oil content and quality parameters.

Conclusions and Outlook

Some species of the walnut-fruit forests in Kyrgyzstan are currently neglected, and one of the factors is the socio-economic transition during the early 1990s, which led to a decreasing demand due to the disturbance of the former institutions and processing chains. The first study results help to draw a picture of walnut qualities of plus-trees, and show that current selection of these trees is insufficient and should be improved. However, further aspects are to be included to assess walnut quality. Kernel colour, shell thickness, and extractability influence the value of walnuts. While no clear correlation could be established between elevation and quality parameters, significant differences were observed among elevation groups. The results may contribute to an improved selection for rejuvenation material. Future work of the SUSWALFOOD project will further investigate environmental conditions characterizing the forest vegetation; analyze nutrient contents of selected neglected forest species; investigate the contribution of such species to the well-being of the local communities; and analyze market and value chains thereby contributing to the development and marketing of value-added products from these forests.

References

Agrolead (2016): Baseline study on wild apple collectors in Kyrgyzstan UEBT/UTZ Certified Herbal Tea Program

Akimaliev DA, Zaurov DE, Eisenman SW (2013): The geography, climate and vegetation of Kyrgyzstan. In: Eisenman SW, Zaurov DE, Struwe L (eds.): Medicinal plants of central Asia: Uzbekistan and Kyrgyzstan. Heidelberg: Springer

Carter J, Grisa E, Akenshaev R, Saparbaev N, Sieber P, Samyn JM (2010): Revisiting collaborative forest management in Kyrgyzstan: What happened to bottom-up decision-making? Gatekeeper - Key highlights in sustainable agriculture and natural resource management No. 148, London: IIED

Hardy K (2015):Investigation into the different farming systems in Jalal-Abad province to support a community-based sustainable afforestation model in the walnut forests of Southern Kyrgyzstan: Financial forecasting 20 years into the future and comparison of farming systems

Hemery GE, Popov SI. (1998): The walnut (Juglans regia L.) forests of Kyrgyzstan and their importance as a genetic resource. Commonwealth For Rev. 77:272–276

Mamadjanov D (2006): Study of varieties and diversity of walnut forms in Kyrgyzstan, Schweizerische Zeitschrift fur Forstwesen 157 (2006) 11: 499-506

National Academy of Sciences of the Kyrgyz Republic (2009): Forest map of the Kyrgyz Republic; Bishkek: Intercooperation;

Orozumbekov A, Musuraliev T, Toktoraliev B, Kysanov A, Shamshiev B, Ormon S (2009): Forest rehabilitation in Kyrgyzstan. In: Keep Asia green; Volume IV “West and CentralAsia”, p. 131-182

Schmidt M (2012): Changing human-environment interrelationships in Kyrgyzstan’s walnut-fruit forests. Forests, Trees and Livelihoods 21(4): 253-266

Undeland A (2012): The Development Potential of Forests in the Kyrgyz Republic; Program on Forests (PROFOR): Washington, DC, pp. 319–364;

Zaurov DE, Belolipov IV, Kurmukov AG, Sodombekov IS, Akimaliev M, Eisenman SW (2013): The medicinal plants of Uzbekistan and Kyrgyzstan. In: Eisenmann SW, Zaurov DE, Struwe L (eds): Medicinal plants of Central Asia: Uzbekistan and Kyrgyzstan. Dordrecht: Springer