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PHYTOCHEMICAL ANALYSIS OF THE PLANT PAULOWNIA SIEBOLD & ZUCC, GROWN IN THE CONDITIONS OF ALMATY REGION

Resume: *Currently, special attention in the field of pharmacy and medicine is focused on the search for new sources of various biologically active substances, including plants. In this article, the woody plant Paulownia Shan Tong is considered as a promising source. This type of tree is widely distributed in natural conditions in the countries of Southeast Asia (China, Japan, Korea, etc.) and due to its healing properties is widely used in folk medicine. Currently, it is introduced and cultivated in many countries. Paulownia is widely used in the forestry industry, in order to obtain biofuels, as a bioremidiant, as well as in folk medicine, its anti-inflammatory, antimicrobial and antioxidant properties are appreciated, It is grown and introduced for the first time in Kazakhstan, therefore, biological, ecological and phytochemical studies of the Paulownia Shan Tong plant have not been carried out in local environmental conditions. The aim of the study is to analyze the phytochemical composition of the leaves of the hybrid Paulownia Shan Tong, grown in the Almaty region. For the first time, a quantitative and qualitative phytochemical analysis of the Paulownia Shan Tong plant grown in Kazakhstan was carried out. A phytochemical analysis of the content of biologically active substances in the leaves of the Paulownia Shan Tong woody plant grown and harvested in the conditions of the Almaty region was carried out. Determination of organic CO2 compounds in Paulownia extract was carried out by gas chromatographic method with mass spectrometric detection, as a result of which terpenes and their lactones, esters, carbohydrates and phenolic compounds were determined, as well as their relative composition in the extract.*
Keywords: *Paulownia Shan Tong, Paulownia CO2 extract, biologically active substances, phytochemical analysis.*

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АЛМАТЫ ОБЛЫСЫ ЖАҒДАЙЫНДА ӨСІРІЛГЕН PAULOWNIA SIEBOLD & ZUCC ӨСІМДІГІНІҢ ФИТОХИМИЯЛЫҚ ТАЛДАУЫ

Түйін: Қазіргі уақытта фармация және медицина саласындағы ерекше назар әртүрлі биологиялық белсенді заттардың, соның ішінде өсімдіктердің жаңа көздерін іздестіруге бағытталған. Осы тұрғыда мақалада Paulownia Shan Tong ағаштектес өсімдігі жапырақтарының фитохимиялық талдамасы қарастырылады. Бұл

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ФИТОХИМИЧЕСКИЙ АНАЛИЗ РАСТЕНИЯ PAULOWNIA SIEBOLD & ZUCC, ВЫРАЩЕННОГО В УСЛОВИЯХ АЛМАТИНСКОЙ ОБЛАСТИ

Резюме: В настоящее время особое внимание в области фармации и медицины направлено на поиск новых источников биологически активных веществ, в том числе растительных. В качестве перпективного источника рассматривается древесное растение

ағаш түрі Оңтүстік-Шығыс Азия елдерінде (Қытай, Жапония, Корея т.б.) табиғи жағдайда кеңінен тараған және емдік қасиеттеріне байланысты халық медицинасында кеңінен қолданылады. Қазіргі уақытта көптеген елдерде өсіріліп, жерсіндіруде. Paulownia орман өнеркәсібінде, биоотын алу мақсатында, биоремидиант ретінде, дәстүрлі медицинада қабынуға және микробқа қарсы, антиоксиданттық қасиеттерін кеңінен пайдаланады. Ал, Қазақстан жағдайында жаңадан өсіріліп, жерсіндіруде, сол себептен жергілікті экологиялық жағдайда Paulownia Shan Tong өсімдігіне биологиялық-экологиялық және фитохимиялық зерттеулер жүргізілмеген. Жұмыстың зерттеу мақсаты Алматы облысында өсірілген Paulownia өсімдігінің Shan Tong гибриді жапырақтарының фитохимиялық құрамын талдау болып табылады.

Жұмыста алғаш рет Қазақстан жағдайында өсірілген Paulownia Shan Tong өсімдігіне сандық және сапалық тұрғыдағы фитохимиялық талдау жасалды. Алматы облысы жағдайында өсіріліп, жиналған Paulownia Shan Tong ағаш тектес өсімдігі жапырағының биологиялық белсенді заттарының құрамына фитохимиялық талдау жүргізілді. Paulownia сығындысындағы CO2 органикалық қосылыстарды анықтау масс-спектрометриялық детекциямен газды хроматографиялық әдісімен жүргізілді, нәтижесінде терпендер және олардың лактондары, эфирлер, көмірсулар және фенол қосылыстары анықталды, сонымен қатар олардың сығындыдағы салыстырмалы құрамы байқалды.

Түйінді сөздер: Paulownia Shan Tong, Paulownia CO2 сығындысы, биологиялық белсенді заттар, фитохимиялық талдау.

Paulownia Shan Tong. Этот вид дерева широко распространен в природных условиях в странах Юго-Восточной Азии (Китай, Япония, Корея и др.) и благодаря своим целебным свойствам широко используется в народной медицине. В настоящее время интродуцируется и культивируется во многих странах. Paulownia широко используется в лесной промышленности, в целях получения биотоплива, в качестве биоремидианта, а также в народной медицине ценят ее противовоспалительные, противомикробные и антиоксидантные свойства, В условиях Казахстана выращивается и интродуцируется впервые, поэтому в местных экологических условиях биолого-экологические и фитохимические исследований растения Paulownia Shan Tong не проводились. Целью исследования работы является анализ фитохимического состава листьев гибрида Paulownia Shan Tong, выращенного в Алматинской области.

В работе впервые проведен количественный и качественный фитохимический анализ растения Paulownia Shan Tong, выращенного в условиях Казахстана. Проведен фитохимический анализ содержания биологически активных веществ в листьях древесного растения Paulownia Shan Tong, выращенных и собранных в условиях Алматинской области. Определение органических соединений CO2 в экстракте Paulownia проводили газохроматографическим методом с масс-спектрометрической детекцией, в результате чего определены терпены и их лактоны, эфиры, углеводы и фенольные соединения, а также их относительный состав в экстракте.

Ключевые слова: Paulownia Shan Tong, экстракт Paulownia CO2, биологически активные вещества, фитохимический анализ.

Introduction. Paulownia (Paulownia Siebold & Zucc) is a plant species belonging to the Paulownia family (Paulowniaceae), including 10 species [1] as well as about 20 hybrid species [2]. Widespread in Southeast Asia (China, Korea, Japan, etc.) under natural conditions. Nowadays it is cultivated under cultural conditions even in southern territories of the USA, Europe and the CIS [3]. This deciduous tree is now grown in many areas of the world, for landscaping and woody purposes [4,5]. Paulownia is a fast-growing, deciduous, tall tree that grows 2-4 m a year and reaches a height of 18-25 m. Leaves open in May and fall with the first frost. Leaves are very large, broadly heart-shaped and arranged opposite each other. It blooms in spring in April-May; the flowers are purplish-pink. In spring, leaves open before budding, Flowers are fragrant, tubular-bell-shaped, 5-6 cm in diameter [6]. Propagation, in natural conditions, by small-winged seeds, occurs by wind, and vegetative propagation by seeds, shoots and cuttings of bushes. It bears fruit after flowering. The fruit has a bipartite oblong box with many seeds inside. The plant was discovered in 1835 by German biologists D. Zuccarini and F. Siebold. There are many popular names: tree of the man, tree of the princess, tree of the dragon, tree of the emperor, tree of the Phoenix [7].

The practical importance of Paulownia is very high, especially in regions where it grows in natural conditions, its medicinal properties have been used by the local population for more than a thousand years. Leaves, roots, stems and inflorescences of the plant are used against various diseases. The biological activity of the plant in anti-dioxant, anti-inflammatory, antimicrobial and antiviral, against various pathogens and cosmetic studies has been revealed [6].

In Chinese phytotherapy, Paulownia has traditionally been used to relieve bronchitis, especially for coughs, asthma and phlegm reduction [2]. It has also been used to treat conjunctivitis, dysentery, enteritis, gonorrhea, hemorrhoids, epidemic parotitis, traumatic bleeding and tonsillitis [8, 9]. Pharmacological experiments have shown that extracts of the fruit can reduce blood pressure, herbal treatment of chronic bronchitis and other types of inflammation is applied [2]. Paulownia leaves may have wound-healing characteristics in the treatment of leg ulcers and frostbite [10]. Chinese folk healers have used Paulownia flowers to treat acne on the skin and fungal infections between the toes [11]. Advanced medical research has revealed many important uses of Paulownia as an anti-inflammatory and antibacterial [12], diuretic, thirst quencher, styptic, insecticidal, and hypotensive [13]. In addition, Paulownia leaves have an antimicrobial action. Aqueous extracts of the leaves have antimicrobial action against Staphylococcus aureus [14], intestinal Salmonella, Pseudomonas aeruginosa, Paenibacillus, Streptococcus pyogenes and Candida albicans [15]. It has been shown that the inhibitory effect of Paulownia leaves can counteract Gram-positive bacteria [16,27].

Currently, there are injections and pills made from flowers and

fruits of Paulownia, more than 130 physiologically active components found in different parts of the Paulownia plant [18, 19, 20]. In the study of medicinal properties of the Paulownia plant, many scientists identify biological substances that have a great antioxidant effect on its leaf, flower, fruit, tree and outer sheath. For example, T. Hee and others have claimed that every part, bark and leaves of Paulownia contain biologically active components such as matteucin and ursulic acid, sesamine in the stem, catapinoside in the sheath and syringin. In addition, the fruits were found to contain alkaloids and fats as well as flavonoids that have antioxidant effects. They also show that the flavonoid composition and the equivalent antioxidant capacity of Trolox in dry and fresh extracts of Paulownia leaves show that this plant can be used for new medicinal purposes [21, 22]. And K.Schnederova and K.Smekal found that the flowers contain flavonoids such as apigenin, quercetin, apigenin-7-O-glucoside, quercetin-3-O-glucoside, 3-methoxyluteolin-7-O-glucoside and tricin-7-O-glucopyranoside [23, 24]. In order to clarify the therapeutic properties against diseases phytochemical studies were conducted on the leaves of the hybrid Paulownia Shan Tong (Tomentosa x Fortunei) collected in September and grown in cultivated form in the conditions of Almaty region. In our studies the phytochemical analysis of locally grown hybrid Paulownia Shan Tong (Tomentosa x Fortunei) revealed 23 biologically active components.

Aim of the study – Analysis of the phytochemical composition of leaves of the Paulownia Shan Tong hybrid grown in Almaty region.

Materials and research methods. The object of research is the leaves of the hybrid Paulownia Shan Tong, grown in the village of Uzynagash, Almaty region, collected in September 2021. The collected raw materials were taken for primary processing and dried in shady conditions. An extract has been prepared for quantitative and qualitative analysis of biologically active substances in the leaves. Dried leaves were crushed and grated with a grater. Weighed 20 g of raw material with electronic scales and placed in 50 ml of 96% ethyl alcohol. The phytochemical analysis was carried out in the «Center of physico-chemical research and analysis methods» (CPCMA) of Al-Farabi Kazakh National University. The analysis was carried out by gas chromatography (Agilent 6890N/5973N) with mass spectrometric detection of CO2 organic compounds in Paulownia extract.

Analysis conditions: sample volume 1.0 µl, sample introduction temperature 250°C, performed without flow separation. The separation process was performed using a DB-35 MS chromatographic capillary column with a length of 30 m, an inner diameter of 0.25 mm, and a film thickness of 0.25 µm. The constant carrier gas velocity (helium) was 1 ml/min. The chromatography temperature ranged from 40 °C (exposure 1 min) to 2800 °C at a heating rate of 5 °C/min (exposure 5 min). Detection was performed in SCAN mode m/z 34-850. Agilent MSD ChemStation software (version 1701ea) was used to control the gas chromatography system, record and process the results and data. Data processing included storage time, determination of peak areas, and processing of spectral information obtained with a mass spectrometric detector. Wiley 7th edition and NIST'02 libraries were used to open the obtained mass spectra (the total number of spectra in the libraries is more than 550 thousand).

Result and discussion. The quantitative composition and qualitative characteristics of the extract from the leaves of the hybrid Paulownia Shan Tong are presented in Table 1. The CO2 chromatogram of the extract is shown in Figure 1.

Phytochemical analysis of plant leaves is as follows: terpenes and diterpenes - 83.85%, ethers and esters - 6.77%, heterocyclic compounds - 1.93%, phenolic compounds - 1.84%, ketones - 0.17%, alkanes - 0.59%, diamines - 1.79%, carbohydrates - 2.85%, aldehydes - 0.21%. Organic active substances of the plant have medicinal and cosmetic value. Among biologically active substances, benzofuran, tetramethyl-2-hexadecene, phytol, squalene have antioxidant properties; trimethyl-1-cyclohexene, butane, dihydroactinidiolide, phytolacetate, ethylinolenate, tetramethylheptadecane have cosmetic value; tetramethyl-2-hexadecene, trimethylpentadecane, squalene have anti-inflammatory properties.

Among the biologically active substances of the plant, the share of phytol is 80.14%. Phytol (C20H40O) is an acclic aliphatic organic chemical compound and belongs to the monounsaturated diterpenes, the basis of which isoprene wastes. It plays a role as a metabolite of plants and algae and is used in schistosomicidal preparations. Also dicyclic diterpene used to produce synthetic forms of vitamin E and vitamin K1 [48].

In terms of pharmacology, phytol and its derivatives have microbial, antitumor and anti-inflammatory, cytotoxic, anti-teratogenic, antibiotic-chemotherapeutic, antidiabetic, hypolipidemic, antispasmodic, antioxidant, antidepressant, immunoadjuvant effects. Thus, phytol can be considered as a new drug. Phytol and some of its derivatives, including phytanic acid, have many biological effects [49, 50].

Conclusion. On the territory of natural cultivation, the tree-like plant Paulownia has inflammatory and antimicrobial, antioxidant properties and cosmetic significance in the forest industry and traditional medicine for its healing properties due to its rapid growth. Taking into account the great practical importance of the tree, interest is growing, and new crops are being grown in Kazakhstan, and land reclamation works are being carried out. Therefore, we have started conducting biological, ecological and phytochemical studies in order to study the Paulownia Shan Tong plant from different angles in the local environmental conditions, to determine the practical significance of this tree species for our country in the future.

For the first time in the work, a quantitative and qualitative phytochemical analysis of the plant Paulownia Shan Tong, grown in Kazakhstan, was carried out. Phytochemical analysis of the content of biologically active substances of the leaves of the woody plant Paulownia Shan Tong, grown and collected in the conditions of Almaty region, was carried out.

Thus, the work determined the quantitative and qualitative composition of active biological substances in the leaves of Paulownia Shan Tong grown in the territory of Almaty region. The results of CO2 chromatographic analysis of the extract revealed 23 components in the leaves, the main components of which are: benzofuran, 2-methyl - 1.93%; phenyl, 4-butyl - 1.84%;

Table 1 - Results of CO2 chromatographic analysis of Paulownia Shan Tong hybrid extract

№	Exposure time, min	Compound/ chemical formula	Probabi lity of identifi-cation, %	Percentage composition, %	Application
11	11,81	Butane, 1,1-diethoxy - $C_8H_{18}O_2$	70	0,96	Butane, one compound of the 1,1-diethoxy acetal group. Aromas [25].
22	16,25	Benzofuran, 2-methyl - C_9H_8O	89	1,93	Benzofuran, a heterocyclic organic compound with 2-methyl-benzene and a furan ring. It has antioxidant properties [26].
33	20,62	Phenol, 4-butyl-C10H14O	83	1,84	Phenyl, 4-butyl, a hydrocarbon radical in organic compounds [27].
44	23,94	(2,6,6-trimethyl-1-cyclohexen-1-yl) - $C_{13}H_{20}O$	63	0,17	2,6,6-Trimethyl-1 is a cyclohexene-1-yl-organic substance of the class of unsaturated ketones. Has a cosmetic value [28].
56	25,31	Phosphoric acid, diethyl nonyl ester - $C_{13}H_{29}O_4P$	68	0,32	Phosphoric acid, dimethylnonyl ether - organic ester of phosphoric acid [29].
66	25,99	α-D-Glucopyranoside, O-α-D-glucopyranosyl-β-D-fructofuranosyl $C_{12}H_{22}O_{11}$	69	2,85	α-d-Glucopyranoside, o-α - D-glucopyranosyl--β-d is a fructo-furanosyl-oligosaccharide organic compound. It is important for agricultural chemistry applications [30].
77	26,75	4,5-Dimethyl-ortho-phenylenediamine - $C_8H_{12}N_2$	71	1,79	4,5-dimethyl-ortho phenylenediamine-organic compound belonging to the class of aromatic diamines [31].
88	27,4	2(4H)-Benzofuranone, 5,6,7,7a-tetrahydro-4,4,7a-trimethyl-, (R) - $C_{11}H_{16}O_2$	65	0,52	2 (4H)-Benzofuranone, 5,6,7,7a-tetrahydro-6-hydroxy-4,4,7 a trimethyl - or Dihydroactinidiolide is a pilot terpene. It has a sweet, tea-like odor and is used as a fragrance [32].
99	29,19	Phytol, acetate - $C_{22}H_{42}O_2$	88	1,23	Phytol acetate - flavors [33].
110	29,83	3,7,11,15-Tetramethyl-2-hexadecen-1-ol - $C_{20}H_{40}O$	74	0,45	3, 7, 11, 15-Tetramethyl-2-hexadecene-1 is an ol-dicyclic hydrogenated diterpene alcohol. Its potential anxiolytic, metabolic modulating, cytotoxic, antioxidant, anticypnotic, anti-inflammatory, immunomodulatory and antimicrobial effects were revealed [34].
111	30,45	2-Pentadecanone, 6,10,14-trimethyl - $C_{18}H_{36}O$	70	0,41	6.10.14-Trimethylpentadecane-2-oh, also known as hexahydrofarnesylacetone, belongs to a class of compounds called sesquiterpenoids. Hexahydrofarnesylacetone has antibacterial, antinociceptive, and anti-inflammatory activity [35].
112	33,39	1,2-Benzenedicarboxylic acid, butyl octyl ester - $C_{20}H_{30}O_4$	61	0,25	1,2-Benzenedicarboxylic acid, butyl ester-esters of phthalic acid. The carrier can play an important role in the absorption, distribution, and release of the ester [36]
113	34,35	Octadecanal - $C_{18}H_{36}O$	67	0,21	Octadecanol - oil aldehyde with a long chain-is used by several insect species as Octadecanal pheromone [36].
114	35,51	Dibutyl phthalate - $C_{16}H_{22}O_4$	92	0,64	Dibutyl phthalate-dibutyl ester of phthalic acid [37].
115	35,84	Phytol - $C_{20}H_{40}O$	90	80,14	Phytol (Greek φυτόν - plant) is an acclic aliphatic organic chemical compound belonging to the monounsaturated diterpenes, which are based on isoprene wastes. It can be used as a substitute for the content of chlorophyll, vitamin E, vitamin K1 [38].

116	37,21	Octadecanoic acid, ethyl ester - $C_{20}H_{40}O_2$	71	1,44	Ethyl octadecanoate-octadecanoate ester obtained by formal condensation between the carboxyl group of octadecanoic acid (stearin) and the hydroxyl group of ethanol [39].
117	37,58	Ethyl 9,12,15-octadecatrienoate - $C_{20}H_{34}O_2$	76	0,9	Ethyl 9,12,15-octadecatrienoate-researched as a skin lightening agent with anti-melanogenesis activity [40].
118	40,17	Tributyl acetylcitrate - $C_{20}H_{34}O_8$	72	0,77	Tributyl acetylcitrate is a chemical compound in the group of carboxylic acid esters [41].
219	41,24	4,8,12,16-Tetramethylheptadecan-4-olide - $C_{21}H_{40}O_2$	62	0,38	4,8,12,16-Tetramethylheptadecane is a 4-olide aliphatic heteromonocyclic compound. This compound belongs to a class of organic compounds called diterpene lactones. Diterpenoids has perfumery and cosmetic value [42].
220	43,34	Oleic acid, eicosyl ester - $C_{38}H_{74}O_2$	64	0,43	Oleic acid, eicosyl ether-oilcyl. It is important as a repellent [43]
221	44,2	Tetratetracontane - $C_{44}H_{90}$	73	0,59	Long-chain tetratetracontan-alkanes consisting of an unbranched chain of 44 carbon atoms [44].
222	44,73	Phthalic acid, di (2-propylpentyl) ester - $C_8H_6O_4$	90	1,06	Phthalic acid, di (2-propylheptyl) ester-a weak chemical organic acid belonging to the class of carboxylic acids of the aromatic series [45, 46].
223	47,31	Squalene - $C_{30}H_{50}$	85	0,72	Squalene is a squamous polyunsaturated hydrocarbon triterpene, actively used in chemistry, immunology and medicine: for the diagnosis and treatment of cancer and viral diseases, including HIV and hepatitis, malaria, tuberculosis, in gene therapy [47].

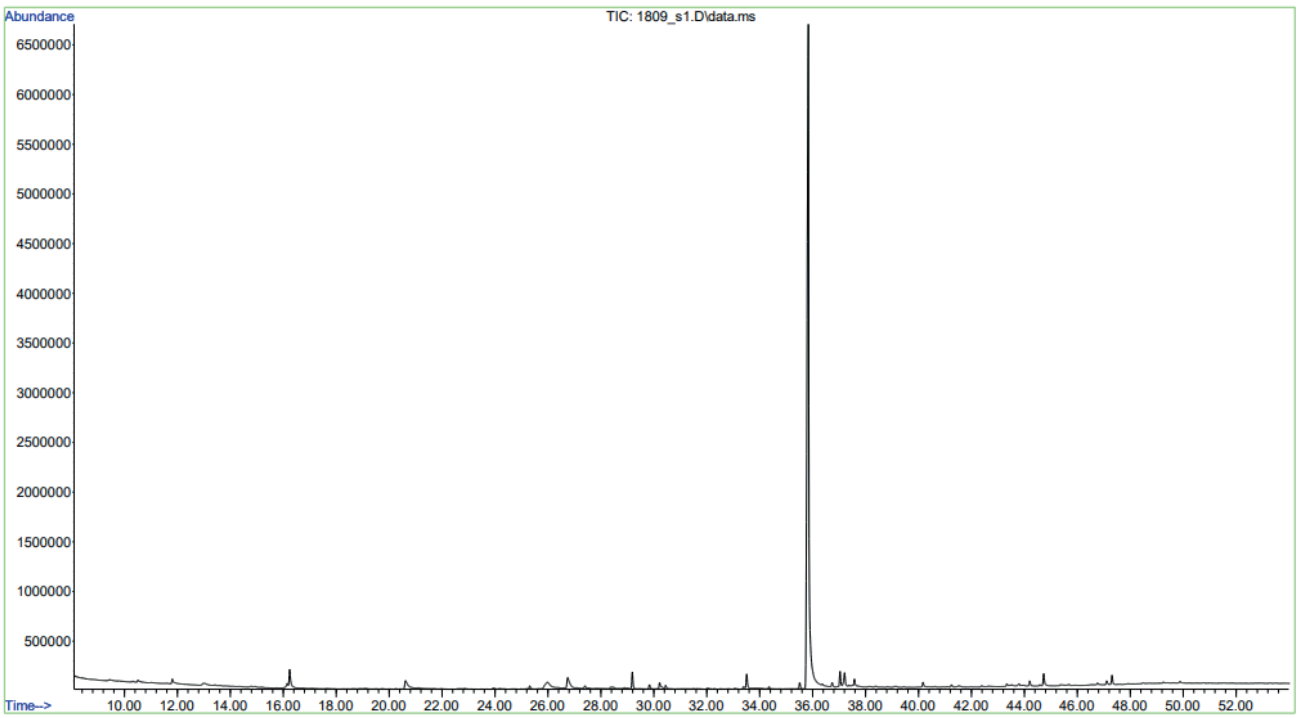

Figure 1 - Chromatogram of CO2 extract of Paulownia Shan Tong

α-D-glucopyranoside - 2.85%; 4,5-dimethyl-ortho-phenylene-diamine - 1,79%; phytol, acetate -1 .23%; phytol - 80.14%; octadecanolic acid - 1.44%; ethyl 9,12,15-octadecatrienoate - 0.90%; phthalic acid - 1,06%; squalene - 0.72%.

Biologically active substances of the Paulownia plant identified in phytochemical analyses are recommended for use in the Kazakhstan pharmaceutical and biotechnology industries.

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