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Constituents, nutritional and pharmacological importance of *Prunus persica* - A review

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Abstract

Prunus persica (Family:Rosaceae) contained carbohydrates,fiber, carotenoids,alkaloids,oils, polyphenols, flavonoids and minerals. Previouspharmacological studiesrevealed that*Prunus persica* possessed gastrointestinal, anti-inflammatory, analgesic,antipyretic, cytotoxic, antioxidant,antiprasitic, acetylcholine esterase inhibition, antimicrobial, antidiabetic, antihistaminic, immunological, protective, vascular, dermatological, antitussive and many other effects. The current review was designedto highlight the chemical and nutritional constituents, pharmacological and therapeutic effects of *Prunus persica.*

Keywords: Nutritional; Constituents; Pharmacology; Therapeutic; *Prunus persica*

1. Introduction

A large and increasing number of patients in the world use medicinal plants and herbs for health purpose. Therefore, scientific scrutiny of their therapeutic potential, biological properties, and safety will be useful in making wise decisions about their use [1-12]. *Prunus persica* (Family: Rosaceae) is probably originated in China and then spread westward through Asia to the Mediterranean countries and later to the Europe. The leaves of the plant were used traditionally as anthelmintic, insecticidal, laxative, sedative, vermicidal, in the treatment of piles, leucoderma, and whooping cough. While the fruits were used as aperients, aphrodisiac, antipyretic, demulcent, antiscorbtic and as brain tonic. The oil of the seeds was consider as abortifacient, and used in the treatment of piles, deafness, earache and stomach troubles in children. Fruit contained carbohydrates, fiber, carotenoids, alkaloids, oils, polyphenols, flavonoids and minerals. Different parts of the plants possessed wide range of pharmacological effects included gastrointestinal, anti-inflammatory, analgesic, antipyretic, cytotoxic, antioxidant, antiprasitic, acetylcholine esterase inhibition, antimicrobial, antidiabetic, antihistaminic, immunological, protective, vascular, dermatological, antitussive and many other effects. The current review highlighted the chemical and nutritional constituents, pharmacological and therapeutic effects of *Prunus persica*.

2. Plant profile

2.1. Synonyms

Amygdalus persica, Amygdalus persica var. aganonucipersica, Amygdalus persica var. compressa, Amygdalus persica var. scleronucipersica, Amygdalus persica var. scleropersica, Persica platycarpa, Persica vulgaris, Persica vulgaris var. compressa,Prunusdaemonifuga, Prunus persica, Prunus persica f. aganonucipersica, Prunus persica var. compressa, Prunus persica var. lasiocalyx, Prunus persica var. persica, Prunus persica var. platycarpa, Prunus persica subsp. platycarpa, Prunus persica f. scleropersica [13].

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2.2. Taxonomic classification

- Kingdom: Plantae,
- Subkingdom: Viridiplantae
- Infrakingdom: Streptophyta
- Superdivision: Embryophyta
- Division: Tracheophyta
- Subdivision: Spermatophytina
- Class: Magnoliopsida
- Superorder: Rosanae
- Order: Rosales,
- Family: Rosaceae
- Genus: Prunus
- Species: *Prunus persica* [14].

2.3. Common names

- Arabic: Khokh
- Chinese: Tao
- English: Peach
- Hindi: Aru, Shaftalu
- Japanese: momo
- Korean: bogsunganamu
- Portuguese: pêssego
- Persian: Aru
- Swedish: persika [15].

2.4. Distribution

It is probably originated in China and then spread westward through Asia to the Mediterranean countries and later to the Europe. The Spanish explorers took the peach to the New World, and as early as 1600 the fruit was found in Mexico, while, large-scale commercial peach growing in United states, did not begin until the 19th century [16].

2.5. Description

Trees, not suckering, 30–100 dm, not thorny. Twigs with terminal end buds, glabrous. Leaves deciduous; petiole 5–10 (–15) mm, <not winged>, glabrous, sometimes glandular distally, glands 1–4, discoid; blade oblong to lanceolate, <folded along midribs, often falcate, (5–)7–15 × 2–4. 5 cm, base cuneate to obtuse, margins crenulate-serrulate, teeth blunt, glandular, apex acuminate, surfaces glabrous. Inflorescences usually solitary flowers, sometimes 2-flowered fascicles. Pedicels 0–3mm, glabrous. Flowers blooming before leaf emergence; hypanthium cupulate, 4–5 mm, glabrous externally; sepals spreading, oblong-ovate, 3. 5–5 mm, margins entire, ciliate, abaxial surface hairy (especially along margins), adaxial glabrous; petals dark pink, obovate to suborbiculate, 10–17 mm; ovaries hairy. Drupes yellow to orange tinged with red, globose, 40–80 mm, velutinous (glabrous in nectarines); mesocarps fleshy; stones ellipsoid, strongly flattened, deeply pitted [17].

2.6. Traditional uses

Prunus persica flowers were used for the treatment of rashes and eczema [18]. The leaves of the plant were used as anthelmintic, insecticidal, laxative, sedative,vermicidal and in the treatment of piles, leucoderma, and whooping cough. While the fruits were used asaperients, aphrodisiac, antipyretic, demulcent, antiscorbtic and as brain tonic. The oil ofthe seeds was consider asabortifacient, and used in the treatment ofpiles, deafness, earache and stomach troubles in children [19-21]. Seeds wereused in the treatment ofwomen's diseases [22].

2.7. Parts used medicinally

Flowers, leaves, fruits, oil and seeds [18-22].

2.8. Chemical constituents

Fruit nutritional quality of late season *Prunus persica* varieties, were: total carbohydrates 11. 41 - 16. 21 g/100 g fresh weight, total sugars 4. 97-6. 19 g/100 g fresh weight (sucrose 3. 41 - 4. 21, glucose 0. 81-1. 60, fructose 0. 24-0. 95,

sorbitol 0. 37-0. 09), sweetness index64. 8-87. 0, total sweetness index 47. 7- 62. 8, total lipids 0. 46- 0. 61 g/100 g fresh weight, energy value 71. 09-80. 39 kcal, total dietary fiber 2. 92-3. 49 g/100 g fresh weight, carotenoids 501. 72- 3721. 97 μg/100 g fresh weight (lutein 206. 97-511. 78, lycopene 157. 03-882. 73, β-carotene 51. 70- 2632. 27), tocopherols (α- tocopherol 245. 12-395. 75 μg/100 g fresh weight). The total mineral content of late season *Prunus persica* varieties was683. 42-2349. 03mg/kg fresh weight (K: 353. 37-1978. 34,P: 200. 00- 300. 00, Ca: < 0. 13,Mg: 2. 77-11. 84, Na: 24. 57-55. 92, Fe: 0. 44-0. 62, Zn: 0. 32-1. 18, Mn: 0. 12-0. 22, Cu: 0. 06-0. 89, Pb: < 0. 10, Cr: < 0. 10) [23].

Alkaloid (persicaside), amygdalin, prunasin, amygdalinic acid, mandelic acid β -D-glucopyranoside, benzyl β –gentiobioside, benzyl β -D-glucopyranoside, fixed oil (persic oil) and sterols were isolated from *Prunus persica* seeds [22, 24-25].

The stem bark contained 6-hydroxy 4-methoxy 2-O-β-D-glucopyranoside, crysophenol 8-O-β-D-glactopyranoside, β-sitosterol and quercetin [26].

Caffeic acid derivative, *p*-coumaric acid derivative, chlorogenic acid, caffeic acid derivative, rutin, kaempferol -3- O-rutinoside, kaempferol -3- O- glucoside, kaempferol -3- O- rhamnoside, caffeic acid, quercetin, kaempferol, quercetin-3-glycoside, quercetin-3-rhamnoside, quinic acid, tannin, urosolic acid and zeaxanthin were identified in the leaves of*Prunus persica* [27-28].

A unique acylated kaempferol glycoside with a rare structure, kaempferol 3-O-*b*-$^{4}C_{1}$- (6-O-3,4-dihydroxyphenylacetyl glucopyranoside)was isolated from the leaves of *Prunus persica* [29].

Prunasin amide, amygdalin amide, prunasin acid, mandelamide, methyl caffeate, caffeic acid, ferulic acid, chlorogenic acid, benzyl α-l-xylpyranosyl- (1 → 6)-β-d-glucopyranoside, prunin, naringenin, nicotiflorin, astragalin, afzelin, and uridine were isolated from *Prunus persica* flowers [30-31].

The total phenolic contents of the leaveswas387. 5 ± 4. 28 mg GAE/g extract, and the total flavonoid content was 241. 7 ±3. 25 mg QE/g extract [29].

However, extensive variation was found among the cultivars fruits in total phenolics (176. 20 ± 7. 18 to 317. 72 ± 4. 66 mg GAE 100/g), radical scavenging activity (44. 25 ± 0. 28 to 78. 17 ± 1. 43%) and reducing power (0. 12 ± 0. 1 to0. 22 ± 0. 03) [32].

Volatiles isolated from *Prunus persica*flowers were: alcohols (propylene,2-ethyl-1-hexanol, 2-propyl-1-heptanol, and alpha-dimethyl-benzenemethanol); esters (isoropylpalmitate); aldehydes (-methyl-butanal, hexanal,heptanal, and decanal); terpenes (toluene, ethylbenzene, p-xylene, styrene, acetophenone); and hydrocarbons (3-ethyl-2-methyl-heptane, dodecane, tridecane, tetradecane, pentadecane, hexadecane) [33].

Oleic acid (67. 7-75. 0%) was the main fatty acid in the kernel oil of *Prunus persica*, followed by linoleic (15. 7-22. 1%) and palmitic (5. 6-6. 3%) acids [34].

The essential oil of the leaves of *Prunus persica* was characterised by higher benzaldehyde content (63. 1–98. 3%). The yield of benzaldehyde was higher during rainy (0. 45 g/100 g fresh leaves) and autumn (0. 44 g/100 g fresh leaves) seasons [35].

Extensive variation was found among the cultivars fruits in vitamin C contents (75. 3 ± 15 to 116. 1 ± 10. 5 mg 100/g), total sugar (13. 52 ± 0. 50 to 20. 84 ±1. 23%), reducing sugar (5. 68 ± 0. 11 to 7. 25 ± 0. 51%) and non-reducing sugar (4. 12 ± 0. 45 to 10. 77 ± 0. 8%) [32].

Oleanolic acid, ursolic acid, (+)-catechin, (+)-4'-*O*-methylcatechin,4,2',4'-trihydroxy-6'-methoxychalcone 4'-*O*- β-D-glucopyranoside, ferulic acid, quercetin 3-*O*-β-D-glucopyranoside and phenyl *O*-β-D-glucopyranoyl- (1→6)-β-D glucopyranoside were isolated from the ethyl acetate fraction of *Prunus persica* fruits [36].

3. Pharmacological effects

3.1. Gastrointestinal effect

The effect of ethyl acetate extract of *Prunus persica* flowers on gastrointestinal motility was evaluated using isolated colon model. The extract showed strong effects *in vitro*. It (10^{-8}-10^{-5} g/ml) caused a concentration-dependent stimulatory effect in rat colonic tissue. Ketotifen, cimetidine, and pyrilamine produced a significant inhibition of contractions caused by the extract. Immunofluorescence and toluidine blue staining revealed increased numbers of mast cells in the extract treated rats, and it increased histamine release from the colonic tissues. The extract possessed significant prokinetic activity mainly via mast cell degranulation [37].

The aqueous crude extract of the leaves of *Prunus persica* was studied for its gut stimulatory effects in isolated Guinea-pig ileum and rabbit jejunum preparations. The extract at the dose of 1-10 mg/ml caused a moderate degree of spasmogenic effect. Pretreatment of the tissue with atropine completely abolished the contractile effect of the plant extract similar to that of acetylcholine which is suggestive of a cholinergic mechanism. In isolated rabbit jejunum preparations, the extract produced a week spasmogenic effect followed by relaxation of the spontaneous contractions at higher doses. Bioassay-directed fractionation revealed that the spasmogenic activity was in the aqueous fraction, while the spasmolytic activity was concentrated in the ethyl acetate fraction. When tested against K^+ induced contraction, both the extract and its ethyl acetate fraction caused a dose-dependent inhibition, suggesting calcium channel blockade [38].

3.2. Anti-inflammatory, analgesic and antipyreticeffects

The anti-inflammatory effects of the methanol extract of *Prunus persica* aerial parts (leaves, fruits and twigs) was investigated in glial cells. The extract inhibited the production of proinflammatory mediators and cytokines in lipopolysaccharide (LPS)-stimulated BV2 cells by suppressing NF-κB translocation and mitogen-activated protein kinase signaling pathways. It also inhibited NO production and NF-κB translocation in cultured primary astrocytes [39].

The alkaloid compound (persicaside) isolated from the methanol soluble extract of *Prunus persica* seed ,inhibited nitric oxide and prostaglandin E 2 (PGE 2) production via suppression of inducible nitric oxide synthase and cyclooxygenase-2expression in rat osteoblast sarcoma cells in concentration-dependent manner [24].

Administering *Prunus persica* var. *nucipersica* kernel extract (50 and 100 mg/kg) in rats reduced carrageenan induced paw edema by 11 and 47% in 1 h, 24 and 33% in 2 h, and 23 and 32% in 4 h. At the higher dose (100 mg/kg), *Prunus persica* var. *nucipersica* kernel extract increased the reaction time in the hot-plate model and produced a significant decrease in the rectal temperature of the pyretic rats, while both doses produced 52 and 59% of writhing inhibition compared to the control group [40].

3.3. Cytotoxic effect

The anti-tumor activity of amygdalin, prunasin, amygdalinic acid, mandelic acid b -D-glucopyranoside, benzyl b –gentiobioside and benzyl b -D-glucopyranoside, isolated from *Prunus persica* seeds was examined in both *in vitro* and *in vivo* assays. All of the compounds significantly inhibited the Epstein-Barr virus early antigen activation induced by tumor promoter. The compounds produced a delay of two-stage carcinogenesis on mouse skin that comparable in potency to (-)-epigallocatechin gallate from green tea [22].

In studying of cytotoxic activity of 1 mg/ml of ethanol leaves extract, ethanol leaves extract loaded in solid lipid nanoparticle (SLNs), extract-free-SLNs, and kaempferol 3-O-*b*-4C1- (6-O-3,4-dihydroxyphenylacetyl glucopyranoside) isolated from the leaves, they caused significant reduction in cell viability of human keratinocytes over 24 h (93%, 90%, 95%, and 89% of the cells survived), respectively [29].

The tumor growth and lung metastasis of MDA-MB-435 breast cancer cells were inhibited by *Prunus persica* polyphenolics in a dose range of 0. 8-1. 6 mg/day, these effects were mediated by inhibition of metalloproteinases gene expression. Modulation of metalloproteinase-2, metalloproteinase-3 and metalloproteinase-13 gene expression may be some of the molecular targets for anti-metastatic activity of *Prunus persica* polyphenolics [41].

Adding of ethanol extract of root of *Prunus persica* in the culture medium inhibited the growth of HepG2 cells in a dose and time-dependent way. It caused sustained M/G2 phase arrest. The expression of mitosis-related protein Cdc25c was impaired upon treatment. The treatment notably suppressed the migration of HepG2 cells and the expression of

extracellular matrix metalloprotease, MMP3 and MMP9. Furthermore,administration of the extractsignificantly inhibited *in vivo* tumor growth in nude mice [42].

The protective effect of the ethanol extract of the flowers of *Prunus persica* against UVB-induced non-melanoma skin cancer was investigated in mice. The topical application of the extract before UVB exposure resulted in a delay of tumor development compared to the control. In tumor multiplicity, low and high concentration of the extract resulted in 25. 9 and 53. 9% reduction at the end of the experiment [43].

3.4. Antioxidant effect

DPPH radical scavenging assay showed that *Prunus persica* fruit extract possessed high percentage inhibition (86. 14±1. 33%) and a very low IC_{50} (17. 5±0. 89 µg/ml) was required for free radical scavenging [44].

The antioxidant activity of the leaves extracts was evaluated using DPPH, ABTS and b-carotene bleaching tests. In all tested samples, a concentration-dependent antioxidant activity was recorded. In the DPPH assay, kaempferol 3-O-*b*-4C1- (6-O-3,4-dihydroxyphenylacetyl glucopyranoside) isolated from the leaves showed the highest scavenging activity followed by ethanol leaves extract loaded in solid lipid nanoparticle (SLNs) and then ethanol leaves extract. The IC_{50} values were 6. 35 ± 3. 40 µg/ml, 8. 79 ± 2. 70 µg/ml, and 10. 5 ± 1. 81 µg/ml respectively compared to vitamin C used as a standard with an IC_{50} of 2 ± 0. 01 µg/ml. The same ranking of activity was also observed against ABTS radicals with IC_{50} value of 3. 91 ± 1. 43 µg/ml, 4. 29 ± 1. 12 µg/ml, and 6. 10 ± 0. 62 µg/ml, respectively, compared with the standard vitamin C with an IC_{50} of 0. 96 ± 0. 02 µg/ml [29].

The antioxidant activities of different fractions (hexane, ethyl acetate, n-butanol and aqueous fractions) of *Prunus persica* fruit were studied using (DPPH), H_2O_2 scavenging, superoxide radical scavenging, iron chelating and reducing power properties. The ethyl acetate and n-butanol fractions possessed the maximum antioxidant activities that were well correlated with total phenolic and flavonoid contents [45].

The reducing power, inhibition of peroxidation using linoleic acid system, and DPPH free radical scavenging activity of the peel and pulp parts of different peach varieties, were investigated *in vitro*. Reducing power of peel and pulp extracts (12. 5 mg/ml) was varied from 2. 57-2. 77 to 1. 54-1. 99. The inhibition of linoleic acid peroxidation and DPPH scavenging activity of the extracts were varied from 70. 8-80. 9% and 66. 8-76. 5% in peels, and 51. 9-60. 1% and 43. 4-49. 1% in pulps respectively [46].

The antioxidant and anti-photoaging activities of 2-methoxy-5- (2-methyl propyl) pyrazine (MMPP) isolated from *Prunus persica* were investigated in terms of matrix metalloproteinase (MMP)-1 and type-1 procollagen expression in ultraviolet (UV)-irradiated human skin fibroblasts. MMPP displayed radical scavenging activity, suppressed MMP-1 expression, and increased type-1 procollagen expression [47].

3.5. Antiprasitic effect

Ethanol and ethyl acetate extracts of *Prunus persica* leaves significantly ($p<0.05$-$p<0.01$) anddose-dependently paralyzed and killed both *Ascaridia galli* and *Pheretima posthuma*. The extracts possessed comparable anthelmintic effect to piperazine citrate against *Ascaridia galli* at a concentration of 60 mg/ml [48].

The crude methanolic extracts as well as its fractions were examined for their insecticidal activity against *Tribolium castaneum*, *Rhyzopertha dominica* and *Callosbruchus analis*. The methanolic and petroleum ether fraction showed moderate activity against *Callosbruchus analis* and *Rhyzopertha dominica.* The dichloromethane fraction possessed moderate activity against *Rhyzopertha dominica*, with no activity against *Tribolium castaneum* and *Callosbruchus analis*. The chloroform fraction exhibited moderate activity against *Rhyzopertha dominica* and *Callosbruchus analis*, while it showed no activity against *Tribolium castaneum* [49].

3.6. Anti-obesity effect

The fruit extract showed anti-lipase activity. The main active compound of anti-lipase activity was oleanolic acid (IC_{50}: 12. 64±0. 65µg/ml) [36]. Flowers of *Prunus persica* possessed anti-obesity effects by improving hepatic lipid metabolism in obese mice [50].

The anti-obesity effects of the water extract flower of *Prunus persica* and its underlying mechanism were investigated in high-fat diet- induced obese mice. The extract significantly reduced body weight, abdominal fat mass, serum glucose, alanine transaminase and aspartate aminotransferase levels, and liver and spleen weights compared to the high- fat diet

control group. The extract suppressed lipogenic gene expression, including stearoyl-CoA desaturase-1 and -2 and fatty acid synthase, and up-regulated the fatty acid β-oxidation gene and carnitine palmitoyltransferase-1, in the liver [51].

The anti-obesity effects of a herbal extract mixture of *Prunus persica* and *Nelumbo nucifera* (HT077) were studied in high-fat diet (HFD) - induced obesity mice. HFD containing 0. 1, 0. 2, or 0. 4% HT077was given for 12 weeks. HT077 significantly reduced final body weights, weight gain, abdominal fat weights, liver weights, and hepatic levels of triglycerides and total cholesterol. It also lowered glucose, cholesterol, ALT, AST, and leptin levels and increased AST/ALT and adiponectin/ leptin ratios and adiponectin levels. HT077also decreased the expression of lipogenic genes and increased the expression of fatty acid oxidation- related genes in adipose tissue [52].

Compounds isolated from *Prunus persica* flowers (mandelamide, methyl caffeate, ferulic acid, chlorogenic acid and naringenin) significantly inhibited adipogenesis. Among them, mandelamide exhibited the maximum inhibitory activity with an IC_{50} of 36. 04 ± 1. 82 μM. Furthermore, mandelamide downregulated the expression of key adipogenic markers (extracellular signal-regulated kinase, c-Jun-N-terminal kinase, P38, CCAAT/enhancer-binding protein α, CCAAT/enhancer-binding protein β, peroxisome proliferator activated receptor γ, and glucocorticoid receptor) [50].

3.7. Acetylcholine esterase inhibitory effect

The acetylcholinesterase inhibitory effects of orally administered *Prunus persica* extracts were examined on the cholinesterase activity in the brain and plasma of rats. After the sequential solvent fractionation of the methanol extract of *Prunus persica*, the highest inhibitory effect was caused by chloroform fraction (75%, withIC_{50} value of 5. 6 microg/ml). Oral administration of water extract or tacrine caused a dose-dependent inhibition of brain and plasma cholinesterase activities. The ID_{50} values of these compounds for brain cholinesterase activity were 2. 7 g/kg and 8. 9 mg/kg, respectively. On the other hand, the ID_{50} values for plasma cholinesterase activity were 18. 6 g/kg and 27. 5 mg/kg, respectively. The ratios of the ID_{50} (plasma < brain) were 6. 0 and 3. 1, respectively. These results suggest that orally administered *Prunus persica* extract penetrated into the brain and inhibited cholinesterase there and that the extract was potent inhibitor of brain cholinesterase in comparison with plasma cholinesterase *in vivo* [53].

The anti-dementia activities of different parts of peach plant were estimated by an acetylcholine esterase (AChE) inhibitory assay. (+)-4'-*O*-methylcatechin (IC_{50}:70. 19±1. 79 μg/ml), 4, 2',4'- trihydroxy-6'-methoxychalcone 4'-*O*-β-D-glucopyranoside (IC_{50}: 85. 21±0. 94μg/ml) and ferulic acid (IC_{50}: 97. 36±2. 85μg/ml)were the main active compounds of anti-dementia activity with potent acetylcholinesterase inhibitory activity [36].

3.8. Antimicrobial effect

The crude methanolic extracts as well as its fractions were investigated against *Escherichia coli*, *Klebsiella pneumonia*, *Pseudomonas aeruginosa*, *Enterococcus faecalis*, *Staphylococcus aureus*, *Bacillus subtilis*, *Salmonella typhi*and *Shigella flexenari*. The petroleum ether fraction possessed significant activity against *E. coli*, moderate activity against *S. aureus* low activity against *K. pneumonia* and *E. faecalis* and noactivity against *P. aeruginosa, B. subtilis, S. typhi* and *S. flexenari.* The dichloromethane fraction also showed good activity against *E. coli, K. pneumonia* and *S. aureus*. The ethyl acetate fraction showed significant activity against *K. pneumonia* and *E. faecalis.* While, the crude methanolic fraction of*Prunus persica* significantly inhibited the growth of *K. pneumonia* and *E. faecalis* [49].

The crude methanolic extracts as well as its fractions were investigated for antifungal activity*. Aspergillus flavus*, *Microsporum canis*, and *Fusarium solani* were sensitive to dichloromethane, chloroform and methanol fractions [49].

3.9. Antidiabetic effect

Quercetin rich ethyl acetate fraction of leaves of *Prunus persica* (100 and 200 mg/kg, orally) was evaluated for anti-diabetic, anti-oxidant and anti-adipogenic activities in streptozotocin- induced diabetic rat model. At 200 mg/kg, quercetin rich ethyl acetate fraction significantly possessed hypoglycaemic activity and improved body weight in diabetic rats. DPPHfree radical scavenging method showed dose dependent scavenging. Preadipocyte differentiation assay showed significant inhibition of differentiation [54].

The extract of flowers of *Prunus persica* exhibited an insulin secretion effect in a glucose-stimulated insulin secretion assay, the compounds isolated from the extract were screened for their efficacy in INS-1 rat pancreatic β-cells. Caffeic acid, methyl caffeate, ferulic acid, chlorogenic acid, naringenin, nicotiflorin, and astragalin increased glucose- stimulated insulin secretion without inducing cytotoxicity. The glucose- stimulated insulin secretion effect of methyl caffeate was similar to gliclazide. It enhanced the related signaling proteins of the activated pancreatic and duodenal homeobox-1 (PDX-1) and peroxisome proliferator-activated receptor-γ (PPAR-γ), the phosphorylation of the total insulin receptor

substrate-2 (IRS-2), phosphatidylinositol 3-kinase (PI3K), and Akt, which influence β-cell function and insulin secretion [31].

The crude extract of peach leaves (1000 mg/kg) suppressed the postprandial elevation in the blood glucose leveldose-dependently after an oral administration of soluble starch to mice, by inhibiting the absorption of glucose in the small intestine of mice [55].

The glucose absorption inhibitory activity was attributed to the acetylated kaempferol glycoside multiflorin A (MFA), which isolated from the methanolic extract of leaf of the edible peach *Prunus persica*. The inhibitory effect of MFA against glucose absorption was demonstrated in the dose dependent manner in mice [56].

3.10. Antihistaminic and immunological effects

The methanol extract of the seed of *Prunus persica* inhibited histamine release in human mast cells. Activity-guided fractionation of the methanol extract yielded 3 cyanogenic glycosidesand 5 phenolic compounds. The effects of the isolated compounds was investigated on histamine release and on the gene expressions of TNF-α and IL-6 in human mast cells. Of the tested compounds, phenolic glycosides suppressed histamine release and inhibited the pro-inflammatory cytokines TNF- α and IL-6 which indicated the anti-allergic inflammatory activity of *Prunus persica* [57].

The ethanol extract of fruits of *Prunus persica* inhibited compound 48/80-induced systemic anaphylaxis and immunoglobulin E- mediated local allergic reactions. Histamine releasing from mast cells was reduced by the extract, the effect of the extract was mediated by modulation of intracellular calcium. The extract also attenuated the phorbol 12-myristate 13-acetate and calcium ionophore A23187 (PMACI) - stimulated expression and secretion of pro-inflammatory cytokines in human mast cells. The inhibitory effect of the extract on pro-inflammatory cytokines was depend on its effect on nuclear factor (NF)-kappa B [58].

3.11. Protective effect

The protective effect of the pericarp extract of *Prunus persica* was studied against cisplatin- induced acute toxicity in mice. The pretreatment with the extract for 7 days prevented the cisplatin- induced decrease in the relative kidney and liver weights. It significantly inhibited both the cisplatin- induced elevation in serum blood urea nitrogen and creatinine levels caused by kidney damage and the cisplatin- induced increase in serum alanine aminotransferase and aspartate aminotransferase levels caused by the liver damage. The extract also caused recovery of the cisplatin-mediated changes in levels of serum nitric oxide and tissue lipid peroxidation, andreduced glutathione content [59].

The protective effect of bark of *Prunus persica* was evaluated in testosterone induced benign prostatic hyperplasia in rats. It exhibited significant amelioration of the testosterone induced effects as indicated from histopathological examination, immunohistochemistry and biochemical studies. It also showed remarkable anti-inflammatory and antioxidant activity signifying their role in interfering with various possible factors involved in benign prostatic hyperplasia [60].

3.12. Vascular effect

The effects of *Prunus persica* pulp ethyl acetate extract on Ang II-induced intracellular Ca^{2+} mobilization, reactive oxygen species (ROS) production and signal transduction events were investigated in cultured vascular smooth muscle cells. Pretreatment with peach ethyl acetate extract inhibited Ang II-induced intracellular Ca^{2+} elevation in vascular smooth muscle cells. Ang II-induced ROS generation, essential for signal transduction events, was diminished by the ethyl acetate extract. The extract also attenuated the Ang II-induced phosphorylation of epidermal growth factor receptor and myosin phosphatase target subunit 1, both of which are associated with atherosclerosis and hypertension [61].

The *Prunus persica* extract was tested for vasorelaxation effects. The results showed that the vasorelaxant effect of the extract was endothelium- dependent, and it was related to the NO-sGC-cGMP, vascular prostacyclin, and muscarinic receptor transduction pathway. K^+ channels, such as the BK_{Ca}, K_V, and K_{ATP} channels, were partially involved in the extract- induced vasorelaxation. The extract was effective in relaxing serotonin (5-HT) - or angiotensin II-induced contraction. The extract attenuated Ca^{2+}- induced vasoconstriction by IP_3 receptors in the sarcoplasmic reticulum membrane, but its vasorelaxant effect was not associated with the influx of extracellular Ca^{2+} via receptor-operative Ca^{2+} channels or voltage-dependent Ca^{2+} channels [62].

3.13. Dermatological effect

The protective effects of fresh unripe peach extract, was evaluated in UV-B irradiated human 3D skin models by measurements of mRNA. Fresh unripe peach extract significantly improved mRNA levels and partially localizations of collagen type XVIII, suggesting that fresh unripe peach extract ameliorates dermal-epidermal junction damages caused by UV-B irradiation [63].

The ethanol extract of the flowers of *Prunus persica* (Ku-35, 100-1,000 microg/ml) inhibited the amount of ^{14}C-arachidonic acid/metabolites release from UVB-irradiated keratinocytes. Ku-35 also possessed the protective activity against UV-induced cytotoxicity of keratinocytes and fibroblasts. In addition, Ku-35 protected from UVB-induced erythema formation in Guinea [64].

The ethanol extract of the flowers of *Prunus persica* (50-200 microg/ml) inhibited UVB- as well as UVC-induced DNA damage in the skin fibroblast cell (NIH/3T3). In addition, the extract inhibited UVB- or UVC- induced lipid peroxidation, especially against UVB-induced peroxidation at concentration higher than 10 microg/ml [43].

3.14. Antitussive effect

Polysaccharide of *Prunus persica* gum consisted of arabinose 43. 2%, xylose 20. 2%, mannose 2. 7% and galagtose 33. 9%. The antitussive activity of polysaccharide was studied in experimental cough induced mechanically in conscious cats. The polysaccharide exhibited significant cough-suppressing activity, which was higher than that of the non-narcotic drug (65).

3.15. Other effects

Kaempferol 3-O-*b*-4C1- (6-O-3,4-dihydroxyphenylacetyl glucopyranoside) isolated from the leaves showed anti-elastase, anti-collagenase and antityrosinase activity with a high% inhibition at 300 µg/ml ([29].

4. Conclusion

This review presented a comprehensive overview of the phytochemical and pharmacological profile of *Pruns persica*, which used for therapeutic purposes as traditional medicine across the world by various cultures. The current review was designed to encourage the clinical investigation of *Pruns persica* as promising herbal drug because of its safety and effectiveness.

Compliance with ethical standards

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