

## 综 述

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# 沙棘及沙棘油活性成分、药理学作用及在疾病治疗中的应用与机制研究进展

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**【摘要】** 沙棘在蒙医和藏医等民族医学中应用悠久,性温,味酸、涩,具有健脾消食、止咳祛痰、活血散瘀的功效。沙棘及其提取物沙棘油(包括籽油和果油)富含维生素、黄酮类、不饱和脂肪酸等活性成分。其中,沙棘果以水溶性成分为主,沙棘油以脂溶性成分为主,二者成分与功效有差异。沙棘具有抗氧化、抗炎、调节免疫等多靶点作用,在心血管、消化、呼吸、皮肤等系统疾病及肿瘤、糖尿病、认知障碍等疾病的治疗中展现潜力。但目前的研究存在部分机制缺乏临床验证、成分协同作用研究不足、剂型单一等问题。综述沙棘及沙棘油的活性成分、药理学作用及在疾病治疗中的应用与机制研究进展,旨在为其进一步研究与开发提供理论依据。

**【关键词】** 沙棘;沙棘果油;沙棘籽油;活性成分;药理作用;临床应用;民族药

## Research progress on active components, pharmacological effects as well as application and mechanism in disease treatment of Hippophae Fructus and Hippophae Fructus oil

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**Abstract:** Hippophae Fructus has a long history of application in ethnomedicines such as Mongolian medicine and Tibetan medicine. It is warm in nature, with a sour and astringent taste, and has the effects of strengthening the spleen and aiding digestion, stopping coughs and eliminating phlegm, and promoting blood circulation and dispersing blood stasis. Hippophae Fructus and its extracts Hippophae Fructus oil (including seed oil and fruit oil) are rich in active components such as vitamins, flavonoids, and unsaturated fatty acids. Among these, Hippophae Fructus fruit primarily contains water-soluble components, while Hippophae Fructus oil primarily contains liposoluble components. The components and effects of these two are different. Hippophae Fructus has multifunctional effects such as antioxidant, anti-inflammatory, and immune-modulating properties, demonstrating potential in the treatment of cardiovascular, digestive, respiratory, and skin system diseases, as well as diseases like tumors, diabetes, and cognitive disorders. However, current research faces challenges such as insufficient clinical validation of certain mechanisms, limited studies on the synergistic effects of components, and a lack of diverse formulations. This article summarizes the active components, pharmacological effects, and potential therapeutic applications research progress of Hippophae Fructus and Hippophae Fructus oil, aiming to provide a theoretical basis for further research and development.

**Keywords:** Hippophae Fructus; Hippophae Fructus fruit oil; Hippophae Fructus seed oil; active components; pharmacological effects; clinical application; ethnic medicine

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沙棘为胡颓子科植物沙棘(*Hippophae rhamnoides* L.)的干燥成熟果实,是蒙医与藏医的常用药材<sup>[1]</sup>,在民族医学中占据重要地位。《中华人民

共和国药典》(以下简称“《中国药典》”)2025 年版记载:沙棘具有健脾消食、止咳祛痰、活血散瘀的功效<sup>[1]</sup>。作为药食同源植物<sup>[2]</sup>,沙棘的药用历史源远流长,我国是世界上最早记载其药用价值的国家,早在公元 8 世纪的藏医典籍《四部医典》<sup>[3]</sup>及《晶珠本草》<sup>[4]</sup>中,均有关于其补肺、活血、治疗培根病(即胃肠黏膜发炎,进而产生淤血、溃疡)的记载。1977 年沙棘被正式纳入《中国药典》<sup>[5]</sup>,20 世纪 80 年代被国家卫生部列为我国第一批药食两用植物品种之首。

沙棘果实蕴含近 200 种已知的活性化合物<sup>[6]</sup>,凭借这些丰富的化学成分,其在医药和化妆品行业中应用广泛<sup>[7]</sup>,具有重要的研究价值与广阔的应用前景。沙棘油是从沙棘中提取的珍贵天然油脂,其提取方法多样,包括超声波辅助酶提取、有机溶剂提取、离心分离以及超临界 CO<sub>2</sub>萃取等<sup>[8]</sup>。依据来源沙棘油可分为沙棘籽油与沙棘果油。沙棘籽油为透明的浅黄色液体,沙棘果油是棕红色的澄清透明油状液,籽油含油量多于果油<sup>[8]</sup>。沙棘油富含 100 多种生物活性成分<sup>[9-10]</sup>,这些丰富的活性成分使沙棘油在医药、化妆品等领域具有显著的应用价值<sup>[11]</sup>,也为后续深入开展药理学研究奠定了坚实的物质基础。

本文梳理沙棘及沙棘油的药理学研究进展,深

入探讨其在疾病治疗中的应用,以期沙棘资源的进一步开发利用及中医药现代化发展提供有益参考。

1 活性成分及药理作用

沙棘果实及其提取物沙棘油(沙棘籽油与沙棘果油)均富含多种生物活性成分,然而二者在成分构成与核心功效方面存在显著差异。沙棘果主要含水溶性成分,其不同部位蕴含酚、类胡萝卜素、黄酮类成分、生育酚、甾醇、不饱和脂肪酸、矿物质、维生素、膳食纤维以及铁、锌等矿物质<sup>[12]</sup>。这些成分赋予沙棘果抗氧化、免疫调节以及改善消化功能等特性<sup>[13]</sup>。沙棘油则以脂溶性成分为主,包括不饱和脂肪酸、脂溶性黄酮、维生素、植物甾醇、生育酚和类胡萝卜素等<sup>[9-11]</sup>,其核心功效侧重于心血管保护、皮肤修复以及调控肠道菌群等<sup>[14-17]</sup>。值得注意的是,沙棘籽油和沙棘果油虽均富含多种活性成分,但因提取部位不同,有效成分有所差异。例如,沙棘籽油在生育酚(质量分数:籽油约 0.381%,果油约 0.287%)和油酸(质量分数:籽油约 22.82%,果油约 17.65%)<sup>[9,18]</sup>含量上较为突出,具有更好的保护心血管<sup>[14,17]</sup>、抗氧化和修复皮肤屏障<sup>[15]</sup>的功效;而沙棘果油中的棕榈油酸(质量分数:果油约 36.09%,籽油约 1.16%)含量更高<sup>[9]</sup>,有更好的抗炎和调节机体免疫反应等作用<sup>[19-20]</sup>。见表 1、表 2。

表 1 沙棘的主要活性成分及其药理作用

| 类别                                       | 主要活性成分                                                    | 药理作用                                                                                                           |
|------------------------------------------|-----------------------------------------------------------|----------------------------------------------------------------------------------------------------------------|
| 维生素类与类胡萝卜素类 <sup>[19,21]</sup>           | 维生素 C、维生素 E、 $\beta$ -胡萝卜素和番茄红素等 <sup>[22]</sup>          | 抗氧化 <sup>[19]</sup> 、增加免疫力、护眼 <sup>[23-24]</sup>                                                               |
| 多糖类 <sup>[25]</sup>                      | 纤维素、半纤维素和果胶等 <sup>[21]</sup>                              | 缓解肠道屏障损伤、抗炎 <sup>[16]</sup> 、改善肥胖 <sup>[25]</sup> 、保护肝脏 <sup>[26]</sup>                                        |
| 三萜类 <sup>[27]</sup> 与甾体类 <sup>[28]</sup> | 齐墩果酸、没食子酸 <sup>[29]</sup> 和 $\beta$ -谷甾醇等 <sup>[30]</sup> | 抗氧化、抗炎 <sup>[29]</sup> 、延缓衰老、保护肝脏 <sup>[27]</sup> 、降血糖 <sup>[31]</sup>                                         |
| 黄酮类与酚类 <sup>[32]</sup>                   | 异鼠李素、槲皮素和山柰酚、花青素等 <sup>[32]</sup>                         | 保护骨骼和乳腺 <sup>[33]</sup> 、抗病毒 <sup>[34]</sup> 、抗氧化 <sup>[35]</sup> 、抗炎 <sup>[36-37]</sup> 、保护肝脏 <sup>[38]</sup> |
| 不饱和脂肪酸类 <sup>[9,39]</sup>                | 棕榈酸、亚油酸、亚麻酸等 <sup>[12,40]</sup>                           | 调节肠道菌群、抗炎 <sup>[41]</sup>                                                                                      |
| 糖和糖的衍生物类 <sup>[21]</sup>                 | 葡萄糖、果糖、木糖等                                                | 提供能量                                                                                                           |
| 矿物元素类 <sup>[21]</sup>                    | 钾、钙、钠、铁等 <sup>[42]</sup>                                  | 保护心血管 <sup>[43]</sup>                                                                                          |

表 2 沙棘和沙棘油的主要活性成分及核心功效的比较

| 类别   | 主要活性成分                                                     | 核心功效                                                                                                                           |
|------|------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------|
| 沙棘   | 酚酸、黄酮类化合物、亚麻酸、亚油酸、维生素 C、 $\beta$ -谷甾醇 <sup>[5]</sup>       | 降血压 <sup>[25]</sup> 、降血脂 <sup>[44]</sup> 、降血糖 <sup>[5]</sup> 、保护肝脏 <sup>[45]</sup> 、保护神经 <sup>[7]</sup> 、抗癌和抗菌 <sup>[46]</sup> |
| 沙棘籽油 | 亚油酸、 $\alpha$ -亚麻酸、油酸、生育酚、植物甾醇 <sup>[9,47]</sup>           | 保护心血管 <sup>[14,17]</sup> 、修复皮肤屏障 <sup>[15]</sup> 、抗疲劳 <sup>[48]</sup> 、抗氧化 <sup>[9]</sup>                                      |
| 沙棘果油 | 棕榈酸 <sup>[49]</sup> 、棕榈油酸、油酸、黄酮、类胡萝卜素、多酚 <sup>[9,47]</sup> | 抗氧化、抗癌和降血糖、降血压 <sup>[50]</sup> 、增强免疫力 <sup>[20]</sup> 、改善肠胃功能 <sup>[51]</sup>                                                  |

2 在疾病治疗中的应用与机制

2.1 心血管系统保护作用 心血管疾病的病理机

制极为复杂,动脉粥样硬化、心肌缺血再灌注损伤等病症相互交织、彼此关联,极大地增加了疾病的防治难度。在传统医学领域,沙棘展现出显著的心

肌保护作用,为心血管疾病的攻克开辟了新路径。研究<sup>[44]</sup>表明,沙棘对心血管系统有许多积极的修复作用,包括调节脂质代谢、血压和血糖水平,以及提供抗氧化活性等。这些特性使得沙棘在心血管疾病的防治中具有巨大潜力。

**2.1.1 降血脂与抗动脉粥样硬化** 血脂异常与动脉粥样硬化作为心血管疾病的关键危险因素,严重影响人们的健康。沙棘凭借其丰富的生物活性成分,在心血管疾病预防与治疗方面展现出显著功效<sup>[44]</sup>。研究<sup>[31]</sup>表明,沙棘中含有的三萜酸能够显著抑制 $\alpha$ -葡萄糖苷酶活性,有效降低餐后血糖水平,进而改善血脂状况。在动物实验中,将沙棘、玫瑰果油与接骨木果提取物用于模型小鼠,结果显示其成功预防了因高脂饮食诱发的动脉粥样硬化<sup>[52]</sup>,为动脉粥样硬化的防治提供了新思路。此外,Hao等<sup>[53]</sup>的研究发现,沙棘籽油可通过增加肠道胆固醇排泄、促进短链脂肪酸的合成,有效降低高胆固醇血症仓鼠的血液胆固醇水平,进而对心脏病起到预防作用。临床研究也进一步证实了沙棘及沙棘油的应用价值。研究<sup>[17]</sup>发现,每日补充0.75 mL沙棘籽油,持续30 d,不仅能使高血压患者的血压恢复正常,也能显著降低高胆固醇人群的总胆固醇、氧化低密度脂蛋白及甘油三酯水平。另一项研究<sup>[54]</sup>显示,111名高胆固醇血症患者每日摄入90 g沙棘果泥90 d后,舒张压和炎症标志物超敏C-反应蛋白均降低。

**2.1.2 抗血栓形成与改善血液流变学指标** 现代药理学研究证实,沙棘在抗凝血方面作用显著。研究<sup>[55-57]</sup>表明,沙棘果实和种子提取物具有抗氧化与抗凝血特性,可以对心血管系统发挥保护作用;不仅如此,沙棘叶片与枝条中所含的活性成分,同样展现出极为突出的血小板聚集抑制作用<sup>[58]</sup>,多方面助力心血管健康。

**2.2 消化系统保护作用** 在传统中医学理论中,沙棘被认为具有健脾消食的功效。2025年版《中国药典》<sup>[1]</sup>记载,沙棘果“酸、涩、温。归脾、胃、肺、心经”,其独特的甘酸之味,可刺激脾胃,起到开胃醒脾之效,进而促进消化液分泌,有效增强胃肠蠕动,改善消化功能。从现代研究的角度来看,沙棘中富含多种对消化功能具有积极促进作用的成分,如沙棘多糖、沙棘黄酮等。

**2.2.1 保护肝脏** 肝脏作为消化系统中的关键器官,对维持人体正常消化代谢功能起着核心作用。

一旦肝脏出现病变,如非酒精性脂肪性肝病(NAFLD)和自身免疫性肝病,不仅会影响自身功能,还会导致整个消化系统紊乱,引发一系列健康问题。Ren等<sup>[27]</sup>研究发现,沙棘中含有的三萜酸具有治疗NAFLD的潜力。Tie等<sup>[38]</sup>发现从沙棘中分离出的两种天然黄酮醇化合物——槲皮素和槲皮苷可以减轻油酸诱导的人肝癌HepG2细胞的脂质积累并有效缓解氧化应激反应,表明其在NAFLD治疗中具有潜在应用价值。不仅如此,在“肠-肝轴”理论中<sup>[59]</sup>,肠道菌群与肝脏健康紧密关联,例如肠道菌群失调会导致肠屏障受损,导致有害细菌及其病原体相关分子模式(PAMP)转移到肝脏中,导致肝脏疾病。沙棘多糖通过改善肠道微生态,间接影响肝脏的脂质代谢与炎症水平,展现出在消化系统与肝脏疾病协同治疗方面的独特优势<sup>[26]</sup>。在自身免疫性肝病的研究中,Zou等<sup>[60]</sup>发现沙棘可以通过抑制核因子 $\kappa$ B(NF- $\kappa$ B)信号转导和调节环磷酸腺苷/蛋白激酶A/环磷酸腺苷反应元件结合蛋白/细胞色素P450 2D6(cAMP/PKA/CREB/CYP2D6)通路,逆转CYP2D6的下调,恢复免疫相关性肝损伤大鼠的肝脏代谢功能。也有临床研究<sup>[61-62]</sup>表明,采用沙棘食疗的方式,可以对NAFLD患者的血脂、血糖及肝酶水平起到一定的改善作用。

**2.2.2 保护胃肠道** 沙棘在胃肠道保护方面发挥着重要作用,且其作用机制多与调节肠道菌群相关。Song等<sup>[63]</sup>发现沙棘提取物能够精准作用于肠道粪杆菌,调控丁酸盐生物合成,从而有效减轻肠道炎症,对溃疡性结肠炎起到治疗作用。Yuan等<sup>[64]</sup>研究发现,含有沙棘多糖的合生元可重构肠道微生物群的结构和组成来调节辅助性T细胞17/调节性T细胞(Th17/Treg)平衡,进而缓解葡聚糖硫酸钠盐(DSS)诱导的小鼠结肠炎,表明沙棘多糖能够通过调节肠道微生态,间接调控肠道免疫平衡。在借助调节肠道菌群治疗疾病方面,沙棘油也表现出色。Lan等<sup>[16]</sup>研究也发现,沙棘多糖能够调节肠道菌群的结构和丰度,改善肠道炎症,同时上调密封蛋白(Occludin)、紧密连接蛋白-1(Claudin-1)和闭锁小带蛋白-1(ZO-1)和黏蛋白-2(MUC-2)的表达,增强肠道屏障功能。尽管其具体作用机制还有待进一步探索,但该研究也为肠道疾病的治疗开辟了新思路。另有研究<sup>[65]</sup>表明,沙棘多糖具备治疗溃疡性结肠炎的作用。一方面,沙棘多糖可以调节肠道菌群,改善肠道微生态环境;另一方面,它能够抑制

NF- $\kappa$ B 信号通路<sup>[66]</sup>,从源头阻断炎症信号的传导,通过双重作用机制,显著缓解溃疡性结肠炎的症状。沙棘黄酮同样具有胃肠道保护作用,在脂多糖(LPS)造成的肉鸡溃疡性结肠炎模型中,补充沙棘黄酮能够降低血清白细胞介素(IL)-1 $\beta$ 、IL-2 水平,缓解肠道损伤,上调空肠黏膜中 *Occludin* 和 *ZO-1* mRNA 表达水平,优化肠道微环境,减少细菌蛋白相对丰度<sup>[67]</sup>。沙棘多酚则能通过调节肠道菌群,影响营养物质的吸收和代谢,提升有效物质的生物利用度并保护胃肠道<sup>[68]</sup>。此外,沙棘果油能够调节小鼠肠道微生物的多样性与组成,增强肠道黏膜的免疫屏障功能,同时激活全身免疫系统,提高机体的免疫防御能力<sup>[20]</sup>。

综上,从调控菌群、修复屏障到调节免疫,沙棘的多种成分通过不同机制发挥了胃肠道保护功能。临床研究<sup>[69-70]</sup>也证实,沙棘不同剂型产品均能有效治疗功能性消化不良并增强胃动力。

**2.3 呼吸系统保护作用** 在呼吸系统疾病的治疗中,沙棘所具备的止咳化痰功效<sup>[1]</sup>,与蒙医、藏医等民族医学理论及现代医学研究高度契合。五味沙棘散是蒙医治疗呼吸系统疾病的常用药,现临床常用的五味沙棘散由沙棘、木香、葡萄干、甘草、栀子 5 种药材配伍而成,常用于缓解和治疗急性咽喉炎、急性支气管炎、慢性阻塞性肺疾病等呼吸系统疾病<sup>[71]</sup>。在基础研究层面,沙棘作用于呼吸系统的药理作用机制也得到了一定程度的阐明。研究<sup>[72]</sup>表明,沙棘可能通过多种机制预防油酸诱导的急性呼吸窘迫综合征,如抑制血管紧张素转换酶活性、释放乙酰胆碱酶、调节炎症因子水平以及抑制凋亡过程。在慢性阻塞性肺疾病的缓解方面,沙棘提取物可通过清除活性氧(ROS)并阻断肿瘤抑制蛋白 p53 (p53)/丝裂原活化蛋白激酶(MAPK)通路抑制铁死亡,从而发挥积极作用<sup>[73]</sup>。异鼠李素作为沙棘中的主要天然黄酮类化合物,对呼吸系统疾病也具有重要治疗作用。它能够通过抑制哺乳动物雷帕霉素靶标蛋白(mTOR)信号通路,有效减轻 LPS 诱导的急性肺损伤<sup>[74]</sup>,同时还对肺动脉高压具有保护作用<sup>[75]</sup>。此外,沙棘相关制剂在肺部疾病治疗中同样表现出色。五味沙棘散能通过塑造肠道菌群、增加短链脂肪酸产生以及增强肠道屏障功能,改善由 LPS 和吸烟诱导的慢性阻塞性肺疾病大鼠的肺功能,并抑制炎症反应<sup>[76]</sup>。沙棘果提取物则可减轻小鼠 LPS 诱导的急性肺损伤中的肺血管高通透性,维

持肺泡-毛细血管屏障的完整性<sup>[77]</sup>。

**2.4 皮肤保护作用** 沙棘及其提取物有很好的抗炎、抑菌、抗氧化活性,常被用于治疗各种皮肤疾病<sup>[12]</sup>。

**2.4.1 治疗烧伤与烫伤** 沙棘油在烧伤、烫伤治疗领域具有显著的疗效,能够有效促进伤口愈合,减轻疤痕形成<sup>[78]</sup>。从作用机制来看,沙棘油蕴含的多种活性成分发挥协同效应,沙棘油中含丰富的不饱和脂肪酸,能够促进正常角质形成细胞与皮肤成纤维细胞的增殖,加速受损皮肤组织的修复进程<sup>[40]</sup>。此外,沙棘油中富含的单不饱和脂肪酸 Omega-7 成分,可通过刺激细胞的新陈代谢,增加端粒酶活性和角质形成细胞生长因子水平,降低伤口的 3-硝基酪氨酸水平,进一步加速烧伤部位的伤口愈合速度<sup>[79]</sup>。临床研究<sup>[80]</sup>表明,在治疗二度烧伤时,沙棘膏相较于磺胺嘧啶银乳膏具有更好的临床疗效。

**2.4.2 抗氧化、抗皮肤炎症** 皮肤炎症如皮炎、湿疹,以及因紫外线伤害、氧化应激引发的皮肤老化和银屑病等,严重影响了人们的生活质量。沙棘及沙棘油凭借其出色的抗炎、抗氧化特性,为这些皮肤问题提供了天然且有效的治疗选择。沙棘籽油作为一种极具潜力的天然皮肤光保护剂,能够有效预防紫外线引起的皮肤成纤维细胞损伤,起到抗老化的作用<sup>[81-82]</sup>。沙棘中的原花青素具有强大的自由基清除能力,而氧化应激导致的自由基积累是皮肤老化的主要诱因之一<sup>[83]</sup>。原花青素可以通过清除自由基,进一步维持胶原蛋白和弹性纤维结构的稳定性,延缓皮肤衰老进程<sup>[84]</sup>。沙棘油对皮肤炎症的治疗也有很好的效果。研究<sup>[85]</sup>表明,沙棘油可通过抑制体内 ROS 释放,降低 NF- $\kappa$ B 表达,有效切断促炎信号转导,减少 IL-1 $\beta$ 、IL-6 等下游促炎性细胞因子释放,不仅能减轻皮肤炎症反应、加速皮肤组织的修复与再生,还能调控因促炎介质大量释放而发病的银屑病患者体内的炎症网络,抑制过度活跃的炎症反应,显著改善皮肤病变,为缓解银屑病症状提供了一种天然干预方案,也为开发新型银屑病治疗手段开辟了新思路。

**2.5 抗肿瘤作用** 沙棘中富含黄酮类和酚类成分,如异鼠李素、槲皮素、没食子酸和原儿茶酸等,这些活性成分在抗肿瘤研究中表现出显著生物活性,具有潜在的应用前景<sup>[66]</sup>。研究<sup>[86]</sup>表明,异鼠李素可以通过诱导胃癌细胞中胱天蛋白酶(Caspase)-3 级联反应的激活,提高与线粒体相关的 B 细胞淋巴瘤-2

蛋白(Bcl-2)/Bcl-2 相关 X 蛋白(Bax)、细胞质中细胞色素 c 的表达,并促进 Caspase-3 及多聚 ADP 核糖聚合酶(PARP)的裂解,导致线粒体电位严重降低和 ROS 的积累,从而有效抑制人胃癌细胞 AGS-1 和 HGC-27 的增殖。异鼠李素还可通过下调 PI3K/Akt 信号级联反应,并触发胆囊癌细胞 G<sub>2</sub>/M 期阻滞,抑制人胆囊癌细胞的增殖与转移,为胆囊癌患者提供了一种新的潜在治疗策略<sup>[87]</sup>。槲皮素则可通过拮抗音猬因子(SHH)和转化生长因子- $\beta$ /Smad(TGF- $\beta$ /Smad)信号通路<sup>[88]</sup>和沉默信息调节因子 2 相关酶 1/单磷酸腺苷活化蛋白激酶(SIRT1/AMPK)信号通路<sup>[89]</sup>,抑制胰腺癌和肺癌细胞的生长、迁移和侵袭,同时诱导癌细胞凋亡。这一系列研究表明,沙棘中的这些活性成分,不仅通过多靶点机制,对多种癌症的发生、发展和转移过程进行调控,还为开发天然抗癌药物提供了新的方向。

**2.6 其他治疗应用及机制** 沙棘凭借丰富多样的活性成分,不仅在上述几类疾病治疗中表现出色,还对其他疾病的治疗发挥着积极作用。

**2.6.1 糖尿病** 氧化应激作为糖尿病慢性并发症的关键发病机制,一直是糖尿病防治领域的研究重点。沙棘凭借出色的抗氧化特性,在糖尿病治疗方面展现出显著的应用潜力。大量研究从动物实验和细胞实验层面,证实了沙棘对糖尿病的积极治疗效果。在动物实验研究<sup>[90]</sup>中,自发性糖尿病大鼠在服用沙棘后,2 型糖尿病症状得到有效缓解,表明沙棘能够在整体层面改善糖尿病的病理状态。此外,沙棘总黄酮同样发挥着重要作用,它通过改善脂质代谢紊乱,调节脂肪细胞因子的分泌,抑制炎症级联反应,从而减轻胰岛素抵抗,缓解 2 型糖尿病症状<sup>[91]</sup>。沙棘提取物及其有效成分,通过抗氧化、调节糖脂代谢和抑制炎症反应等多途径协同作用,为 2 型糖尿病的防治提供了新的干预策略,在未来糖尿病治疗领域具有广阔的研究和应用前景。

**2.6.2 认知功能障碍类疾病** 代谢综合征相关认知并发症,正逐渐成为危害公众健康的重要问题,然而现有的干预手段在效果和安全性上仍存在局限。而沙棘中的活性成分——异鼠李素与多糖,凭借独特的作用机制,使其在这类疾病中有很好的应用前景。沙棘黄酮所含的异鼠李素,在应对高脂高糖饮食诱导的认知障碍时,展现出很好的治疗作用。研究<sup>[92]</sup>表明,异鼠李素能够精准抑制 MAPK 和 NF- $\kappa$ B 信号通路的过度激活,调控炎症因子的释放,

减轻大脑的炎症反应,从而有效缓解认知障碍,极有希望成为应对代谢综合征相关认知并发症的营养干预物质。与此同时,沙棘果中富含的多糖,同样在认知障碍防治领域表现出色。研究<sup>[93]</sup>证实,沙棘多糖可以通过抑制氧化应激,减少自由基引起的神经细胞损伤,并且有效抑制炎症反应,降低大脑中炎症介质水平,同时可抑制重组 Kelch 样 ECH 相关蛋白 1(Keap1)的表达,提高阿尔茨海默病小鼠大脑中核因子红细胞 2 相关因子 2(Nrf2)、抗氧化酶超氧化物歧化酶(SOD)和谷胱甘肽过氧化物酶(GSH-Px)的水平,进而显著改善阿尔茨海默病小鼠的认知功能障碍。总体而言,沙棘中的异鼠李素和多糖,分别从调节 MAPK、NF- $\kappa$ B、Keap1/Nrf2 信号通路、抑制氧化应激与炎症反应等多个维度发挥作用,为攻克代谢综合征相关认知并发症提供了极具潜力的干预策略,值得开展深入的研究与探索。

### 3 结语

沙棘作为一种具有悠久药用历史的植物,在蒙医、藏医等民族医学理论体系中占据独特地位。从藏医古籍记载的“补肺、活血、治疗培根病”<sup>[3]</sup>,到现代研究揭示的多靶点药理活性,沙棘的药用价值得到了多维度验证。沙棘中富含的黄酮类、多糖类、萜类等活性成分,在抗炎、抗肿瘤、保护消化系统及心血管系统等方面展现出显著功效,且作为药食两用的民族药,其安全性能也较高。然而,目前沙棘的研究仍存在一些不足。作用机制方面,部分通路研究仅停留在细胞实验阶段,尚缺乏在体动物模型验证,需通过动物实验进一步确认其体内生物学效应,以支撑后续应用研究;成分研究方面,虽已鉴定出多种活性成分,但对部分微量成分及成分间协同作用机制的研究还不够深入,可利用超高效液相色谱-串联质谱(UPLC-MS/MS)等技术,识别沙棘中含量极低但可能具有活性的成分,同时可结合网络药理学与生物信息学,构建“成分-靶点-通路”网络等研究其相互作用机制;从制剂开发角度看,沙棘提取物的剂型较为单一,生物利用度有待提高,限制了其临床应用范围,可开发一些缓控释制剂以及靶向制剂提高其递送效率。

沙棘研究具有广阔前景,应进一步深入研究沙棘及沙棘油的作用机制,尤其是在民族医学理论指导下的作用靶点和信号通路;应加强对其有效成分的提取、分离和纯化研究,明确关键活性成分的构效关系,基于此设计开发出更多高效、安全且具有

更高生物利用度或靶向性的民族药制剂;同时,也应进行临床研究,验证其在更多疾病治疗中的有效性和安全性,推动沙棘从传统民族药向现代精准药物转化,为其在民族医学领域的广泛应用提供更坚实的基础。

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