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EFFECT OF DIETARY ASTRAGALUS HERBS ON POULTRY PRODUCTIVE PERFORMANCE AND HEALTH STATUS BIOMARKERS

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ABSTRACT

Astragalus, a well-known medicinal herb, has been a fundamental component of traditional Chinese medicine for centuries. Its root is widely processed into various supplement forms, such as liquid extracts, powders, capsules, and teas. The plant's roots contain bioactive compounds, including saponins, polysaccharides, flavonoids, amino acids, glycosides, alkaloids, organic acids, and essential trace elements, which contribute to its therapeutic potential. Traditionally, Astragalus has been used to manage conditions, such as diabetes, nephritis, leukemia, and uterine cancer, as well as for its diuretic and tonic properties. Astragalus polysaccharides (APS), derived from Astragali Radix, play an essential function in immunity and other health benefits. The herb is known to support various physiological functions, including kidney health, digestion, liver function, female reproductive health, cardiovascular performance, respiratory health, and immune defense. Additionally, Astragalus exhibits anti-aging properties, protects against oxidative stress, and helps maintain bone integrity. Its antioxidant-rich compounds, particularly Astragalosides, are essential for respiratory tract protection. This article explores the structural composition and bioactive compounds of Astragalus, emphasizing its potential benefits in poultry health and the underlying mechanisms contributing to its effectiveness.

***Keywords**:* Astragalus, chemical composition, antioxidants, immunostimulants, growth promoter

INTRODUCTION

The use of antibiotics in the poultry industry has been restricted. As a result, the phytogenic feed additives have been increasingly utilized to serve this purpose, as well as for other benefits (Ali *et al.,* 2025). Dietary supplementation of herbs and other ingredients that contain bioactive components boost the productivity and health status of poultry (Maznouk, 2025). The perennial plant *Astragalus membranaceus* (AM), which belongs to the Leguminosae family, is also known as Radix Astragali in Latin and Huangqi in Chinese medicine (Jia *et al.,* 2012). Broadly recognized in traditional Chinese medicine (TCM), AM has long been utilized for its immune-enhancing properties and as a remedy for ailments such as fatigue, anorexia, cardiovascular disorders, diarrhea, and respiratory infections. The dried root of AM is rich in various bioactive constituents, including polysaccharides, astragalosides, flavonoids, saponins, amino acids, and trace

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minerals, which contribute to its pharmacological properties (Zhao *et al.,* 2012).

Among its many bioactive components, Astragalus polysaccharides (APS) have been extensively studied for their diverse biological activities. APS exhibit powerful immune-modulating, antioxidant, antiviral, anti-inflammatory, anti-stress, and anti-aging effects (Li and Zhang, 2009). In poultry, dietary APS supplementation at 220 ppm yielded enhancements in both types of adaptive immune (humoral and cellular immunity), as well as offer protection against bacterial, viral, and parasitic infections (Li *et al.,* 2009).

Additionally, polysaccharides of Astragalus contribute to deep immune support by regulating specific immune cell functions, making the herb particularly beneficial under conditions of environmental or physiological stress. Unlike synthetic pharmaceuticals, Astragalus is rarely used as a standalone remedy in TCM but is typically combined with other herbs to enhance its therapeutic effects. *Astragalus membranaceus* Bunge's roots, Astragali Radix, have liver protective, antioxidant, antiviral, and antihypertensive properties (Shahrajabian *et al.,* 2019). This review delves into the chemical composition of AM (Figure 1), its physiological benefits in poultry, and the mechanisms through which it enhances overall health and disease resistance.

Figure 1: Astragalus herb (Farag & Alagawany, 2019)

AM structure and biochemical constitution

AM exhibits a consistent chemical profile, primarily composed of bioactive polysaccharides, saponins, and flavonoids, along with phenolic acids, amino acids, and sugars (Zhang *et al.,* 2009a). Its dried roots are particularly rich in polysaccharides and steroidal saponins, known as astragalosides, with polysaccharides being the most significant. These include Astragalan I, II, and III (APS-I, APS-II, APS-III), differing in sugar composition. Astragalin (Kaempferol-3-O-β-Glucoside) is the predominant polysaccharide (Tang & Eisenbrand, 1992). The saponins in AM are categorized into 7 types based on their cycloastragenol backbone (Zhu *et al.,* 2010; Zhang *et al.,* 2011). AM also contains diverse flavonoids, including flavones, flavonols, and isoflavones (Ibrahim *et al.,* 2013), along with pigments such as formononetin and isoliquiritigenin (Lin *et al.,* 2000). Additional compounds include cyclo-astragenol, betaine, choline, soyasaponin, and β-sitosterol. Furthermore, AM seed oil is abundant in unsaturated fatty acids like oleic and linoleic acids, as well as saturated fatty acids, such as stearic and palmitic acids (Yin *et al.,* 2015).

Mode of action of astragalus

Antiviral effect of astragalus

Astragalus polysaccharide has been shown to enhance immune responses and antiviral activity. Zhang *et al.* (2010) reported that APS stimulates CD86 expression, which serves as a ligand for CTLA-4 and CD28. In contrast, Zhuge *et al.* (2012) found that APS suppresses the expression of CTLA-4 and CD28 in swine that is infected with fever virus, while having no impact on TGF-β mRNA levels. Interestingly, APS increased IL-10 mRNA expression in CSFV- and PRRSV-infected pigs. Further research indicated that APS administration elevated values of TGF-β and IL-2 mRNA. However, when APS was used alongside PRRSV or CSFV infection, it had no effect on TGF-β expression, but led to increased IL-10 mRNA levels and reduced IL-2, CTLA-4, and CD28 transcription. These findings suggest that APS modulates immune responses in PRRSV- or CSFV-infected cells through distinct mechanisms.

APS has also been identified as a potential adjuvant for the foot-and-mouth disease virus (FMDV) vaccine. When administered alongside the vaccine, APS enhances macrophage phagocytic activity, promotes dendritic cell (DC) maturation, stimulates T lymphocyte (LYM) proliferation, upregulates cytokine expression, and boosts antibody production. These immunomodulatory effects suggest that APS could improve the efficacy of other vaccines as well. Given its availability, affordability, and minimal side effects, APS presents itself as an effective vaccine adjuvant (Zhang *et al.,* 2010).

The biological effects of APS extend beyond immune modulation. Studies have examined its influence on productivity, liver and gut health, and antiviral activity in zebrafish. Li *et al.* (2021) concluded that supplementation with 0.01% APS enhanced gut integrity, antiviral defenses, and growth rates in zebrafish. However, a higher concentration of 0.02% APS posed potential risks to liver health.

A purified component of *Astragalus membranaceus*, known as Astragaloside IV, has demonstrated antiviral properties. Shang *et al.* (2011) found that Astragaloside IV effectively inhibits human adenovirus (HAdV-3) replication in cell cultures and prevents virus-induced apoptosis.

Antioxidant effects of Astragalus

Additionally, *Astragalus membranaceus* polysaccharides (AMP) have been evaluated as dietary supplements for poultry. Zhang *et al.* (2013) observed that incorporating 5 g of AMP particles per kg of broilers' feed enhanced blood antioxidant activity; although no significant impact on growth and feed utilization was noted. Smaller AMP particles exhibited a stronger antioxidant effect, indicating their potential as antioxidant additives for broiler diets.

Further research by Alagawany *et al.* (2022) highlighted the benefits of injecting broilers' eggs with polysaccharides of AM. The treatment significantly improved antioxidant enzyme activity while reducing oxidative stress markers, with the highest antioxidant response observed at a dosage of 4.5 mg. The glutathione (GSH) concentration was maximized at this dose, while malondialdehyde (MDA) levels decreased compared to control groups. The potent antioxidant properties of AMP are attributed to its diverse bioactive compounds, including polysaccharides, saponins, flavonoids, and glucuronic acid, which exhibit strong free radical scavenging capabilities (Zhang *et al.,* 2013; Cho *et al.,* 2007; El Kenawy *et al.,* 2010). Several studies have linked these compounds to antioxidant and free radical neutralization activities (Li *et al.,* 2009; Zhang *et al.,* 2013; Wang *et al.,* 2010; Attia *et al.,* 2019). The flavonoid content in *Astragalus membranaceus* exists in both glycosidic and free forms (Ibrahim *et al.,* 2013).

Moreover, Zuo *et al.* (2012) demonstrated that adding AMP in laying hen diets improved antioxidant status and reduced lipid peroxidation of both blood and egg yolks. The optimal AMP supplementation level was between 5 and 10 g/kg of feed.

Effect of astragalus in immunity

Farag & Alagawany (2019) reported that incorporating *Astragalus membranaceus* (AM) into poultry diets has demonstrated significant immunomodulatory effects, both in vivo and in vitro. These benefits arise from its ability to enhance T and B lymphocyte proliferation, stimulate cytokine secretion through macrophage and B cell activation, and strengthen humoral immunity by increasing specific antibody titers.

Qiao *et al.* (2018) observed that crude *Astragalus* supplementation influenced gut microbiota composition, leading to a shift in fecal microbial communities. Similarly, El-Shafei & Al-gamal (2013) found that including *Astragalus membranaceus* root powder (AMRP) in the diet lowered oxidative enzyme levels, boosted blood levels of total protein, albumin, and immunoglobulin G (IgG), and improved the albumin-to-globulin (A/G) ratio, indicating enhanced immune function.

Xi *et al.* (2014) examined the impacts of *Astragalus* stems and leaves ultrafined powder (SLASUP) on chickens vaccinated against Newcastle disease (ND). Their findings revealed that SLASUP supplementation significantly increased antibody titers and elevated IFN-γ and IL-2 in serum, suggesting a stronger immune response. Further research by Zhang *et al.* (2018) established the antiviral activity of SLASUP against infectious bronchitis virus (IBV), as it reduced viral replication and downregulated the expression of TNF-α, IL-1β, IL-6, and IL-8.

Guo *et al.* (2012) also examined the impact of SLASUP on immune function, reporting that it enhanced humoral immunity by increasing serum immunoglobulins in Immunocompromised birds. Meanwhile, Fan *et al.* (2012) explored the consequences of *Astragalus* polysaccharide liposomes (APSL) on chickens' immunity. Their study showed that APSL promoted both B and T lymphocyte proliferation and worked synergistically with lipopolysaccharides (LPS) to amplify immune responses in ND-vaccinated chickens. Wang *et al.* (2015) investigated the influences of sulphated APS (SAPS) and APS addition on gastrointestinal health and immune regulation. They found that these compounds improved gut morphology by increasing intraepithelial lymphocyte numbers and enhancing jejunal villus height. Additionally, SAPS and APS supplementation reduced plasma nitric oxide (NO) concentrations, suppressed NO production in T lymphocytes, and lowered the heterophil-to-lymphocyte (H:L) ratio in LPS-induced inflammatory conditions, highlighting their potential role in mitigating immune stress.

Zhang *et al.* (2007) emphasized the long-standing use of *Astragalus membranaceus* in TCM as a potent immunostimulant. Today, it remains widely utilized as a natural immunomodulator, particularly for supporting immune function in chronic degenerative diseases.

Effect of astragalus on performance

Zhang *et al.* (2013) investigated the impact of AMP on broiler performance when added to the feed at 5 g/kg. Their findings indicated that, under the study's specific feeding conditions, the addition AMP exerted insignificant changes in broiler growth. These results are comparable to earlier one of Wang *et al.* (2010), who also found that AMP at the same dosage did not enhance growth performance. However, Wang *et al.* (2010) documented a significant improve in weight gain by supplementing AMP at a higher dose of 10 g/kg over a 42-day feeding period. These results propose that low growth response in birds receiving lower doses of AMP may be attributed to insufficient supplementation, rather the absence of beneficial effects. Previous studies have demonstrated a dose-dependent effect of Astragalus polysaccharides on growth performance (Chen *et al.,* 2003; Zhang *et al.,* 2009b). Furthermore, the particle size of AMP appeared to have no measurable impact on broiler growth, implying that the concentration of AMP in the diet is a more crucial factor than its physical form. Zhang *et al.* (2009a) observed a similar trend in research involving ginger root processed to comparable particle sizes.

Alagawany *et al.* (2022) examined the outcomes of injecting broilers' eggs *with Astragalus membranaceus*. Their study found no changes in birds' live weight, or their weight gain, due to treatment. However, feed consumption patterns varied depending on the dosage. A quadratic increase in feed intake was observed at 3 mg of *Astragalus membranaceus* administration during the first 21 days. In contrast, lower dosages (1.5 and 3 mg) directed to a decrease (P=0.004) in feed consumption between days 22 and 35. Over the entire experimental period, feed intake was significantly influenced in both linear and quadratic manners. Additionally, the feed-to-gain ratio improved significantly when birds received 1.5 mg of *Astragalus membranaceus*. These findings were supported by El Shafei & Al-gamal (2013), who reported insignificant influence of AM on growth and feed utilization in broilers. Notably, chicks that hatched from eggs injected with 1.5 mg of *Astragalus membranaceus* exhibited the lowest total feed intake over the experimental period. The absence of strong growth in their study may be attributed to the relatively low levels of *Astragalus membranaceus* tested. Other research has focused specifically on the effects of Astragalus polysaccharides the primary bioactive compound in *Astragalus membranaceus* root powder, when used at different concentrations (Chen *et al.,* 2003; Zhang *et al.,* 2009b).

Similarly, the size of *Astragalus membranaceus* polysaccharide particles did not influence broiler performance, reinforcing the idea that dosage plays a more significant role than particle size in determining its effects (Zhang *et al.,* 2009a; Zhang *et al.,* 2013).

Beyond broilers, *Astragalus membranaceus* supplementation has shown benefits for laying hens. Zuo *et al.* (2012) found that incorporating AMP into hen feeds (up to 15 g/kg) resulted in improvements in egg production. Additionally, there was a tendency (P≤0.1) for improved feed efficiency (FE), although average daily feed intake (ADFI) and egg weight remained unaffected over the 10-week study period. These findings suggest that AMP could serve as a natural feed additive capable of enhancing the reproductive performance of laying hens.

Effect of astragalus in hematobiochemical parameters Alagawany *et al.* (2022) examined the outcomes of injecting broilers' eggs with APS on various hematological indices, including white blood cells (WBCs), LYM, mid-sized cells (MID), granulocytes, red blood cells (RBCs), hemoglobin, hematocrit, Mean Corpuscular Volume (MCV), Mean Corpuscular Hemoglobin (MCH), and platelets. Their findings revealed insignificant quadratic effects on these indices by the administration with APS. Nonetheless, some indicators, such as WBCs, lymphocytes, mid-sized cells, granulocytes, hemoglobin, and hematocrit, showed a linear response to APS administration, suggesting a dose-dependent effect on certain blood components.

A separate study by Han *et al.* (2024) examined the effects of fermented *Astragalus* polysaccharides (FAP) in broiler diets. Their results demonstrated that adding 2% FAP to feed significantly increased serum albumin (ALB) and immunoglobulin A concentrations. Moreover, FAP supplementation (4%) led to elevated serum glucose (GLU) concentrations at 28 days (P<0.05). The study further revealed that 2% FAP enhanced (P<0.05) IgA levels at 28 days, and both immunoglobulin G and A levels on day 42. However, neither FAP nor unfermented *Astragalus* polysaccharides (UAP) significantly affected the other blood markers.

Beyond poultry, APS has been widely studied for its metabolic and lipid-regulating properties. Liu *et al.* (2013) found that APS could alleviate hyperlipidemia in mice by modulating lipid metabolism. Chen *et al.* (2013) reported that APS significantly reduced serum leptin levels in obese rats that consumed high-fat-included diets, while simultaneously increasing adiponectin concentrations that contribute to the regulation of glucose and lipid metabolism. In another study, Tang *et al.* (2016) showed that APS effectively improved the blood lipid profile of rats with non-alcoholic fatty liver disease. The treatment also mitigated fat accumulation in the liver, indicating a potential role for APS in managing metabolic disorders.

Comparative research by Qianfa *et al.* (2017) assessed the lipid-lowering properties of APS against simvastatin in hyperlipidemic rats. Their findings revealed that APS exhibited a cholesterol-reducing effect similar to that of simvastatin when administered over an extended period. Notably, APS outperformed simvastatin in improving liver enzyme activity, suggesting additional hepatoprotective benefits.

Antibacterial effects of astragalus

Research has highlighted the diverse bioactive compounds present in *Astragalus* species and their potential benefits in poultry production. Abbas & Zayed (2005) identified and isolated seven saponins from *Astragalus suberi L.*, demonstrating their antibacterial properties against a wide variety of bacteria. The isolated compounds exhibited minimum inhibitory concentration levels above 100 ppm, suggesting their potential role as natural antimicrobial agents.

Qiao *et al.* (2018) explored the effects of fermenting *Astragalus* and found that the process led to an increase in the bioactive compounds like polysaccharide, that are associated with interactions with intestinal microbiota, which in turn activated enzymes that contributed to a greater count of the Lactobacillus population. The presence of *Lactobacillus* supports feed utilization efficiency by complementing other beneficial gut microbes (Saito *et al.,* 2003). Flavonoids present in *Astragalus* play an essential function in maintaining the integrity of gastrointestinal barriers, modulating gut hormone secretion, and influencing microbiota composition (Oteiza *et al.,* 2018). Additionally, gastrointestinal microbiome population can hydrolyze the absorbed saponins, potentially generating bioactive metabolites that contribute to overall health benefits (Lim *et al.,* 2015). Consequently, broilers fed diets supplemented with fermented *Astragalus* exhibited improved growth performance, likely due to increased availability of bioactive compounds, such as polysaccharides, flavonoids, and saponins, along with microbially-generated organic acids. Studies have demonstrated that fermented and unfermented *Astragalus* can influence the microbial population of broiler feces. Qiao *et al.* (2018) were the first to report that dietary supplementation with *Astragalus* modulates the microbial community composition in broilers. The gut microbiota is known to transform herbal compounds into beneficial metabolites, thereby improving overall gut health and microbiota diversity (Xu *et al.,* 2017). It is speculated that *Astragalus* exhibits a key role against inflammation and oxidation (Kim *et al.,* 2013), that help regulate immunity and could decrease reliance on antibiotics in poultry farming (Kallon *et al.,* 2013). Furthermore, when subjected to fermentation by *Lactobacillus*, *Astragalus* produces significant quantities of organic acids which promote the helpful bacteria population while suppressing pathogenic ones, further boosting the intestine health.

A study by Qiao *et al.* (2022) utilized Principal Coordinate Analysis (PCoA) to examine the impact of different dietary treatments on broiler microbiota composition. The results revealed distinct clustering of microbial communities in control (*CON*), antibiotic-treated (*ANT*), APS -supplemented, and *Glycyrrhiza uralensis polysaccharide*-supplemented (*GPS*) groups. APS and GPS supple-mentation significantly decreased Bacteroidetes, Bacteroides, Faecalibact-erium, Desulfovibrio, and Butyrici-coccus while increasing Firmicutes, Prevotella, Parabacteroides, Ruminococcus, and Alistipes. These microbiota shifts correlated with improved broiler performance, including weight gain, feed utilization, immune markers, and intestinal barrier proteins, highlighting the role of these polysaccharides in enhancing gut health and overall growth.

Medicinal uses of astragalus

The dried roots of *Astragalus* species (*Radix Astragali*) contain a variety of bioactive compounds known for their protecting impacts on multiple body organs and tissues. These protective properties are particularly evident in diseases associated with oxidative stress (Hong *et al.,* 1992; Shahzad *et al.,* 2016). *Astragalus* is widely recognized for its role in boosting the body's primary energy systems, supporting immune function, and enhancing metabolism, respiration, and detoxification processes (Liu *et al.,* 2017). Additionally, *Astragalus glycyphyllos* has been traditionally used as a medication against hypertension and inflammation (Nikolov, 2006). One of the most remarkable constituents found exclusively in the *Astragalus* genus is cycloastragenol (CA), an aglycone derived from cycloartane-type glycosides. This compound is known to extend the proliferation of T lymphocytes by enhancing telomerase enzyme activity that plays a crucial role in delaying cell aging (Valenzuela *et al.,* 2009).

Effect of astragalus on fertility

Research has demonstrated that supplementing poultry diets with *Astragalus* extracts can significantly enhance performance. Zuo *et al.* (2012) reported that increasing the inclusion of *Astragalus membranaceus* polysaccharides (AMP) from 5 to 15 g/kg in poultry diets exerted a linear improvement in egg production rate and total egg mass. However, the feed conversion ratio (feed intake/egg mass) showed a tendency to decrease ($P = 0.097$), indicating improved feed efficiency. Notably, the increase in egg mass was attributed to a higher egg production rate rather than an increase in egg weight.

Similarly, Alagawany *et al.* (2022) explored the impact of adding *Astragalus membranaceus* in quail breeders' diets during the 8- to 16-week laying period. They found that different inclusion levels of *Astragalus* offered distinct benefits:

- 2 g/kg diet: Improved laying performance
- 5 g/kg diet: Enhanced hatchability characteristics and increased IgG levels
- 4 g/kg diet: Strengthened eggshell quality
- 3 g/kg diet: Reduced total cholesterol
- 1 g/kg diet: Improved feed conversion ratio

Beyond its impact on egg production, *Astragalus* extracts also benefit male reproductive health. Wu *et al.* (2017) demonstrated that APS could enhance testicular function by modulating key enzymatic activities. In their study, 16 genes were found to be upregulated, while 17 were downregulated, indicating significant biological responses at the molecular level. Additionally, Hu (2023) observed that APS supplementation improved the antioxidant capacity of sperm exposed to bisphenol A (BPA), an environmental toxin. This resulted in enhanced sperm capacitation and overall reproductive efficiency, suggesting that APS could mitigate the adverse effects of environmental stressors on fertility.

CONCLUSION

The use of medicinal plants and their bioactive compounds as supplements in poultry diets continues to gain attention due to their antimicrobial, immunomodulatory, and overall health-enhancing properties. The supplementation of poultry feed with *Astragalus membranaceus* has demonstrated numerous benefits, including improved immune responses, enhanced reproductive performance, and optimized feed efficiency. These effects are mediated by the ability of *Astragalus* to stimulate lymphocyte proliferation (T and B cells), activate macrophages, and enhance humoral immunity by increasing specific antibody titers. As a result, *Astragalus* presents itself as a valuable natural alternative to synthetic growth promoters and immune enhancers in poultry farming, offering a sustainable approach to improving production efficiency and bird health.

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تأثير أعشاب الأستراجلس كإضافة علفية على الأداء الإنتاجي ومؤشرات الحالة الصحية في الدواجن

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تُعد عشبة الأستراجلس مكونًا أساسيًا في الطب التقليدي الصيني منذ قرون لما له من خصائص طبية معروفة. يُستخدم جذر الأستراجلس بشكل واسع في تصنيع مكملات غذائية متعددة الأشكال، مثل المستخلصات السائلة، والمساحيق، والكبسولات، والشاي. تحتوي جذور هذه النبتة على مركبات نشطة بيولوجيًا، بما في ذلك السابونين، والسكريات المتعددة، والفلافونويدات، والأحماض الأمينية، والجليكوسيدات، والقلويدات، والأحماض العضوية، وعناصر أثرية أساسية، والتي تساهم جميعها في فوائدها العلاجية. من الناحية التقليدية تم استخدم الأستراجلس لعلاج امراض السكري، والتهاب الكلى، وسرطان الدم، وسرطان الرحم، بالإضافة إلى خصائصه المدرة للبول والمنشطة. تُعد السكريات المتعددة المستخلصة من جذر الأستراجلس ذات أهمية كبيرة لدعم المناعة والفوائد الصحية الأخرى. يُعرف عن هذه العشبة دعمها لمجموعة من الوظائف الفسيولوجية، بما في ذلك صحة الكلى، والهضم، ووظائف الكبد، وصحة الجهاز التناسلي الأنثوي، والأداء القلبي الوعائي، وصحة الجهاز التنفسي والمناعي. علاوة على ذلك، يُظهر الأستراجلس خصائص مضادة للشيخوخة، ويحمي من الإجهاد التأكسدي، ويساعد في الحفاظ على سلامة العظام. تُعتبر مركباته غنية بمضادات الأكسدة، خاصة الأستراجالوسيدات، ضرورية لحماية الجهاز التنفسي. تستعرض هذه الدراسة التركيب البنائي والمركبات النشطة بيولوجيًا في الأستراجلس، مع التركيز على فوائده المحتملة لصحة الدواجن والآليات الكامنة وراء فعاليته.