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### ORGANIC COMPOUND FERTILIZER MADE FROM TRADITIONAL CHINESE MEDICINE RESIDUES THAT CAN IMPROVE BARREN SOIL AND ITS PROCESSING METHOD

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The invention relates to the field of resource utilization of solid waste and fertilizer production technology, specifically to an organic compound fertilizer made from traditional Chinese medicine residues that can improve barren soil and its processing method. The production method includes mixing traditional Chinese medicine residues, drying them in air or at low temperatures, and grinding them into powder. The mixture consists of 60-80 parts traditional Chinese medicine residues, 6-8 parts urea, 12-14 parts superphosphate, 2.5-3.5 parts potassium chloride, 4-6 parts harmless molybdenum tailings, and 1.5-2.5 parts humic acid. Water is added to adjust moisture content to 40%-60%, and the mixture is stored under a plastic cover in a sealed condition for 5-7 days, then dried to a moisture content of  $\leq 10\%$  and processed into granular fertilizer. The fertilizer is suitable for the Loess Plateau, offering comprehensive nutrient content, environmental friendliness, and suitability for industrialization, with significant promotion value.

# ORGANIC COMPOUND FERTILIZER MADE FROM TRADITIONAL CHINESE MEDICINE RESIDUES THAT CAN IMPROVE BARREN SOIL AND ITS PROCESSING METHOD

## 5 **Technical Field**

The invention relates to the field of resource utilization of solid waste such as traditional Chinese medicine residues and molybdenum tailings, and fertilizer production technology, specifically to an organic compound fertilizer made from traditional Chinese medicine residues that can improve barren soil and its processing  
10 method.

## **Background Technology**

The Loess Plateau is a major grain-producing area in China and a traditional dryland farming region. Due to natural factors such as fragmented terrain, loose soil,  
15 and concentrated rainfall, the area suffers from severe soil erosion, barren arable land, and low land productivity. Specifically, the soil is seriously deficient in organic matter, and except for abundant available potassium, nitrogen and phosphorus nutrients are lacking, and trace elements such as effective zinc, boron, manganese, and molybdenum are also deficient. However, the current fertilization in this region is still  
20 dominated by nitrogen and phosphorus inorganic fertilizers like urea and diammonium phosphate, resulting in serious soil structure damage, increased risk of soil erosion, further soil degradation, and declining land productivity.

Waste traditional Chinese medicine residues are rich in organic matter, nitrogen, phosphorus, potassium, amino acids, crude fiber, and other nutrients. When applied  
25 to farmland, they can increase the soil's organic matter, alkaline hydrolyzable nitrogen, available phosphorus, and available potassium content, improve soil aggregate structure, and significantly enhance the soil's physical and chemical properties. These residues are light in weight, have good aeration properties, and can improve soil permeability, making them a high-quality organic fertilizer raw material mainly for

increasing organic matter content and supplementing nitrogen and phosphorus. Tests have shown that adding a certain proportion of traditional Chinese medicine residues to the soil where corn is planted improves the absorption rate of nutrients by the corn plants, leading to more vigorous growth; it also enhances the root growth environment of the corn, promotes the development of the root system, increases yield, and improves the quality of the corn. Therefore, scientifically utilizing waste traditional Chinese medicine residues to produce organic fertilizers to address the challenges of waste residue treatment and disposal and to reduce environmental pollution has gained widespread attention.

At present, although there are various production methods for organic fertilizers based on traditional Chinese medicine residues, they have the following problems: First, the raw material components are numerous, requiring more than 10 kinds of raw materials, and some even up to 17, which leads to low utilization efficiency of traditional Chinese medicine residues and a complicated production process. Second, using only traditional Chinese medicine residues and other organic wastes to produce organic fertilizers results in large amounts of usage, slow effectiveness of macronutrients like nitrogen, phosphorus, and potassium, insufficient content of secondary and trace elements like calcium, magnesium, sulfur, iron, manganese, silicon, zinc, molybdenum, and boron, and low bioavailability. Therefore, existing organic fertilizers cannot effectively target the barren soils of the Loess Plateau, making it difficult to fertilize the soil, improve soil structure, and address soil erosion issues.

### **Summary of the Invention**

The purpose of the present invention is to provide an organic compound fertilizer made from traditional Chinese medicine residues that can improve barren soil and its processing method to solve the problems mentioned in the background technology.

To achieve the above purpose, the present invention provides the following technical solution: An organic compound fertilizer made from traditional Chinese medicine residues that can improve barren soil, comprising the following parts by weight: 60-80 parts of traditional Chinese medicine residues, 6-8 parts of urea, 12-14

parts of superphosphate, 2.5-3.5 parts of potassium chloride, 4-6 parts of harmless molybdenum tailings, and 1.5-2.5 parts of humic acid.

Preferably, it comprises the following parts by weight: 70 parts of traditional Chinese medicine residues, 7 parts of urea, 13 parts of superphosphate, 3 parts of potassium chloride, 5 parts of harmless molybdenum tailings, and 2 parts of humic acid.

Preferably, it comprises the following parts by weight: 60 parts of traditional Chinese medicine residues, 8 parts of urea, 12 parts of superphosphate, 3.5 parts of potassium chloride, 4 parts of harmless molybdenum tailings, and 2.5 parts of humic acid.

Preferably, it comprises the following parts by weight: 80 parts of traditional Chinese medicine residues, 7 parts of urea, 14 parts of superphosphate, 2.5 parts of potassium chloride, 6 parts of harmless molybdenum tailings, and 1.5 parts of humic acid.

A processing method for the organic compound fertilizer made from traditional Chinese medicine residues that can improve barren soil, comprising the following steps:

(1) Mixing the traditional Chinese medicine residues evenly, drying them in the air or at low temperatures, and grinding them into powder;

(2) Taking 60-80 parts of traditional Chinese medicine residues, 6-8 parts of urea, 12-14 parts of superphosphate, 2.5-3.5 parts of potassium chloride, 4-6 parts of harmless molybdenum tailings, and 1.5-2.5 parts of humic acid, and mixing them evenly;

(3) Adding water to the above mixed materials to adjust the moisture content to 40%-60%, covering with plastic film, and storing in a sealed condition for 5-7 days;

(4) Spreading out to dry or drying until the moisture content is  $\leq 10\%$ , and processing into granular fertilizer.

Preferably, in step (3), the storage temperature in the sealed condition is controlled to be  $\leq 60^{\circ}\text{C}$ .

Preferably, in step (4), the drying temperature is controlled to be  $\leq 70^{\circ}\text{C}$ .

The beneficial effects of the present invention compared to the existing

technology are:

1) The present invention targets the characteristics of barren soil on the Loess Plateau, focusing on increasing organic matter, supplemented by nitrogen and phosphorus and enriched with trace elements, providing comprehensive nutrient content in the fertilizer. The present invention combines traditional Chinese medicine residues, urea, superphosphate, potassium chloride, molybdenum tailings, and humic acid in specific proportions, which addresses the drawbacks of pure traditional Chinese medicine residue organic fertilizers, such as slow effectiveness of macronutrients and insufficient content of secondary and trace elements, while aligning with China's fertilizer reduction policy. This can significantly promote the combined use of organic and inorganic fertilizers, increase soil organic matter content, reduce the risk of nitrogen and phosphorus non-point source pollution due to soil erosion in the Loess Plateau region, and achieve environmental friendliness.

2) The raw material composition of the present invention is relatively simple, requiring only six raw materials, which effectively meets the improvement needs of barren soil on the Loess Plateau.

3) The present invention reduces the usage of traditional Chinese medicine residues, avoiding the drawbacks of large amounts of pure traditional Chinese medicine residue fertilizer application.

4) The present invention fully considers the timeliness of the fertility of traditional Chinese medicine residue organic fertilizer by adding small amounts of highly effective inorganic nitrogen, phosphorus, and potassium elements to enhance the fertility efficiency of traditional Chinese medicine residue organic fertilizer, promoting the combined use of inorganic and organic fertilizers.

5) The present invention, by adding harmless molybdenum tailings as a source of secondary and trace elements, reduces the use of inorganic secondary and trace element substances, advancing the national process of inorganic fertilizer reduction, and also contributes to the clean production and comprehensive utilization of waste from molybdenum mining enterprises. It provides a resourceful solution for the treatment of large amounts of molybdenum tailings, addressing the significant waste

of land resources, serious environmental issues, and safety hazards caused by tailings accumulation.

6) The present invention does not use fermentation agents and does not require fermentation of traditional Chinese medicine residues during the preparation process, ensuring production safety. The entire production process is simple to operate, with low technical requirements for operators, significantly reducing labor costs.

7) The present invention, through the chelation of humic acid with traditional Chinese medicine residues, increases the content of free humic acid in the fertilizer and the bioavailability of nutrients, enhancing the disease resistance and stress tolerance of crops.

8) The present invention, based on traditional Chinese medicine residues, combines urea, superphosphate, potassium chloride, molybdenum tailings, and humic acid, completing the formulation of the organic compound fertilizer in one step. The implementation steps are simple, the process flow is straightforward, the industrial operation process is simple, conducive to intensive production, and meets the needs of industrialization, making it highly promotable.

9) High degree of harmlessness and sanitation: By chelating humic acid (HA) with traditional Chinese medicine residues, the present invention significantly increases the content of free-state humic acid and the bioavailability of secondary and trace elements, improving the ability to chelate heavy metal ions such as Pb, Cr, and Cd, and reducing the ecological risk of heavy metals brought by fermented traditional Chinese medicine residues and molybdenum tailings.

10) The introduction of organic matter from traditional Chinese medicine residues increases the soil's particle aggregation capacity, promoting the formation of stable soil aggregates, effectively improving the stability of the loess structure, and mitigating soil erosion.

### **Specific Embodiments**

The following provides a clear and complete description of the technical solutions in the embodiments of the present invention. It is evident that the described

embodiments are merely part of the embodiments of the invention and not all embodiments. Based on the embodiments of the present invention, all other embodiments obtained by those skilled in the art without creative efforts fall within the scope of protection of the invention.

5           The present invention provides an organic compound fertilizer made from traditional Chinese medicine residues that can improve barren soil, comprising the following parts by weight: 60-80 parts of traditional Chinese medicine residues, 6-8 parts of urea, 12-14 parts of superphosphate, 2.5-3.5 parts of potassium chloride, 4-6 parts of harmless molybdenum tailings, and 1.5-2.5 parts of humic acid.

10           The processing method for an organic compound fertilizer made from traditional Chinese medicine residues that can improve barren soil comprises the following steps:

(1) Mixing the traditional Chinese medicine residues evenly, drying them in the air or at low temperatures, and grinding them into powder;

(2) Taking 60-80 parts of traditional Chinese medicine residues, 6-8 parts of urea, 15 12-14 parts of superphosphate, 2.5-3.5 parts of potassium chloride, 4-6 parts of harmless molybdenum tailings, and 1.5-2.5 parts of humic acid, and mixing them evenly;

(3) Adding water to the above mixed materials to adjust the moisture content to 40%-60%, covering with plastic film, and storing in a sealed condition for 5-7 days, 20 controlling the storage temperature to  $\leq 60^{\circ}\text{C}$ ;

(4) Spreading out to dry or drying until the moisture content is  $\leq 10\%$ , and processing into granular fertilizer; controlling the drying temperature to  $\leq 70^{\circ}\text{C}$ .

Example 1:

25           An organic compound fertilizer made from traditional Chinese medicine residues suitable for barren soils of the Loess Plateau is produced as follows:

1. Mix the traditional Chinese medicine residues evenly, air dry them until the moisture content is  $\leq 8\%$ , and grind them into powder using a grinder.

2. Take 70 parts of traditional Chinese medicine residue powder, add 7 parts of urea, 13 parts of superphosphate, 3 parts of potassium chloride, 5 parts of harmless 30 molybdenum tailings, and 2 parts of humic acid, and mix evenly.

3. Place the above mixed materials in a fermentation tank (length × width × height: 2m × 2m × 1m), add water to adjust the moisture content to 45%, cover with plastic film, and ferment for 7 days to chelate traditional Chinese medicine residues, inorganic nutrients, and humic acid. Monitor temperature and moisture changes daily; if the temperature exceeds 60°C, apply appropriate turning and ventilation to cool down.

4. Spread out to dry until the moisture content is below 10%, and process into granular fertilizer using a granulator (model: Kp-150c) according to organic fertilizer granulation requirements. During processing, ensure the temperature does not exceed 70°C.

10 Example 2:

An organic compound fertilizer made from traditional Chinese medicine residues suitable for barren soils of the Loess Plateau is produced as follows:

1. Mix the traditional Chinese medicine residues evenly, low-temperature (60°C) dry them until the moisture content is  $\leq 5\%$ , and grind them into powder using a crusher.

2. Take 60 parts of traditional Chinese medicine residue powder, add 8 parts of urea, 12 parts of superphosphate, 3.5 parts of potassium chloride, 4 parts of harmless molybdenum tailings, and 2.5 parts of humic acid, and mix evenly.

3. Place the above mixed materials in a fermentation tank (length × width × height: 2m × 2m × 1m), add water to adjust the moisture content to 60%, cover with plastic film, and ferment for 6 days to chelate traditional Chinese medicine residues, inorganic nutrients, and humic acid. Monitor temperature and moisture changes daily; if the temperature exceeds 60°C, apply appropriate turning and ventilation to cool down.

4. Dry until the moisture content is below 10%, and process into granular fertilizer using a granulator (model: Kp-150c) according to organic fertilizer granulation requirements. During processing, ensure the temperature does not exceed 70°C.

Example 3:

An organic compound fertilizer made from traditional Chinese medicine residues suitable for barren soils of the Loess Plateau is produced as follows:

30 1. Mix the traditional Chinese medicine residues evenly, low-temperature (60°C)

dry them until the moisture content is  $\leq 5\%$ , and grind them into powder using a grinder.

2. Take 80 parts of traditional Chinese medicine residue powder, add 7 parts of urea, 14 parts of superphosphate, 2.5 parts of potassium chloride, 6 parts of harmless molybdenum tailings, and 1.5 parts of humic acid, and mix evenly.

5           3. Place the above mixed materials in a fermentation tank (length  $\times$  width  $\times$  height: 2m  $\times$  2m  $\times$  1m), add water to adjust the moisture content to approximately 40%-60%, cover with plastic film, and ferment for 5 days to chelate traditional Chinese medicine residues, inorganic nutrients, and humic acid. Monitor temperature and moisture changes daily; if the temperature exceeds  $60^{\circ}\text{C}$ , apply appropriate turning and  
10           ventilation to cool down.

4. Spread out to dry until the moisture content is below 10%, and process into granular fertilizer using a granulator (model: Kp-150c) according to organic fertilizer granulation requirements. During processing, ensure the temperature does not exceed  $70^{\circ}\text{C}$ .

15           Tests have determined that the organic compound fertilizers made from fermented traditional Chinese medicine residues according to Examples 1-3 meet the quality standards for bio-organic fertilizers (NY 884-2012): total nutrient content (N +  $\text{P}_2\text{O}_5$  +  $\text{K}_2\text{O}$ ) (on a dry basis)  $\geq 11\%$ ; organic matter  $\geq 42\%$ ; moisture content  $\leq 10\%$ .

Among the above examples, Example 1 is the best embodiment.

20           The crop yield and soil fertility effects of the organic compound fertilizer in Example 1 are illustrated as follows:

The organic compound fertilizer made from traditional Chinese medicine residues in the present invention, when used for grain crops (such as corn), is recommended for use as a one-time basal fertilizer applied uniformly across the entire soil layer (with  
25           little or no follow-up fertilization), with an application rate of 250-350Kg per mu.

Test crop: Corn, variety Yudan 958.

Test location: Yan'an Ecological Experimental Station, Institute of Earth Environment, Chinese Academy of Sciences.

Test period: June to October 2016; May to October 2017.

30           The comparison fertilizers used were hydrolyzed oil residue organic fertilizer

(Control 1, produced by Shandong Guangda Fertilizer Technology Co., Ltd.) and nitrogen-phosphorus-potassium inorganic fertilizer (Control 2). The application rates of the hydrolyzed oil residue organic fertilizer and the fermented traditional Chinese medicine residue organic compound fertilizer in the present invention were the same, at 250Kg per mu; the nitrogen-phosphorus-potassium inorganic fertilizer was applied according to the recommended fertilization rate for high-yield corn. All fertilizers were applied uniformly across the entire soil layer as a one-time basal fertilizer, with no follow-up fertilization. Table 1 shows the crop yield increase effect of the organic compound fertilizer made from traditional Chinese medicine residues in the present invention (the 2016 growing season was shorter, so the yield is expressed as the total dry weight of above-ground biomass at harvest); Table 2 shows the improvement in the main soil fertility indicators after two years (i.e., 2017) of applying the organic compound fertilizer made from traditional Chinese medicine residues in the present invention.

Table 1: Crop Yield Improvement Effects of Organic Compound Fertilizer Made from Traditional Chinese Medicine Residues

Example Case	Yield (kg/mu)			Yield Increase (%)	
	Control 1	Control 2	Invention Organic Fertilizer	Compared to Control 1	Compared to Control 2
2016	109.89	159.84	164.85	50.01	3.13
2017	440.55	667.53	701.74	59.29	5.12

Table 2: Improvement in Soil Fertility Indicators After Two Years (2017) of Applying Organic Compound Fertilizer Made from Traditional Chinese Medicine Residues

Fertility Indicator	Content				Increase (%)		
	Original Value	Control 1	Control 2	Invention Organic Fertilizer	Compared to Original Value	Compared to Control 1	Compared to Control 2
Organic	2.76	5.08	4.75	6.06	119.6	19.3	27.6

Matter (g/kg)								
Alkaline Hydrolyza ble Nitrogen (mg/kg)	12.24	19.69	26.26	35.45		189.6	80.0	35.0
Available Phosphor us (mg/kg)	2.39	6.48	11.4	14.44		504.2	122.8	26.7
Available Potassiu m (mg/kg)	86.78	92.08	97.36	105.78		21.9	14.9	8.6
Available Iron (mg/kg)	4.38	6.27	6.60	7.31		66.9	16.6	10.8
Available Mangane se (mg/kg)	1.85	2.54	2.46	2.90		56.8	14.2	17.9
Available Copper (mg/kg)	0.41	0.49	0.50	0.53		29.3	8.2	6.0
Available Zinc (mg/kg)	0.34	0.65	0.53	0.67		97.1	3.1	26.4
Available	0.026	0.031	0.029	0.056		115.4	80.6	93.1

Molybdenum (mg/kg)							
Available	0.29	0.34	0.31	0.42	44.8	23.5	35.5
Boron (mg/kg)							

From the data in Table 1, it can be seen that the invention significantly increases crop yield compared to Control 1 and slightly exceeds the yield of Control 2. The data in Table 2 shows that compared to Control 1 and Control 2, the invention significantly improves the effective content of macronutrients and micronutrients such as organic matter, nitrogen, phosphorus, potassium, iron, manganese, copper, zinc, molybdenum, and boron in the soil, effectively enhancing soil fertility.

Despite the detailed description of the present invention with reference to the aforementioned embodiments, those skilled in the art can still make modifications to the technical solutions described in the previous embodiments or carry out equivalent replacements of some technical features. Any modifications, equivalent replacements, or improvements made within the spirit and principle of the present invention should be included within the scope of protection of the present invention.

## CONCLUSIES

1. Een organische samengestelde meststof gemaakt van residuen van traditionele Chinese geneeskunde voor verbetering van arme grond, met de volgende gewichtsverhoudingen: 60-80 delen residuen van traditionele Chinese geneeskunde, 6-8 delen ureum, 12-14 delen superfosfaat, 2,5-3,5 delen kaliumchloride, 4-6 delen onschadelijk molybdeenafval, en 1,5-2,5 delen humuszuur.

2. De organische samengestelde meststof gemaakt van residuen van traditionele Chinese geneeskunde voor verbetering van arme grond volgens conclusie 1, met de volgende gewichtsverhoudingen: 70 delen residuen van traditionele Chinese geneeskunde, 7 delen ureum, 13 delen superfosfaat, 3 delen kaliumchloride, 5 delen onschadelijk molybdeenafval, en 2 delen humuszuur.

3. De organische samengestelde meststof gemaakt van residuen van traditionele Chinese geneeskunde voor verbetering van arme grond volgens conclusie 1, met de volgende gewichtsverhoudingen: 60 delen residuen van traditionele Chinese geneeskunde, 8 delen ureum, 12 delen superfosfaat, 3,5 delen kaliumchloride, 4 delen onschadelijk molybdeenafval, en 2,5 delen humuszuur.

4. De organische samengestelde meststof gemaakt van residuen van traditionele Chinese geneeskunde voor verbetering van arme grond volgens conclusie 1, met de volgende gewichtsverhoudingen: 80 delen residuen van traditionele Chinese geneeskunde, 7 delen ureum, 14 delen superfosfaat, 2,5 delen kaliumchloride, 6 delen onschadelijk molybdeenafval, en 1,5 delen humuszuur.

5. Een verwerkingswerkwijze voor de organische samengestelde meststof gemaakt van residuen van traditionele Chinese voor verbetering van arme grond volgens een van de conclusies 1-4, met de volgende stappen:

(1) Het gelijkmatig mengen van de residuen van traditionele Chinese geneeskunde, deze in de lucht of bij lage temperaturen drogen, en malen tot poeder;

(2) Het nemen van 60-80 delen residuen van traditionele Chinese geneeskunde, 6-8 delen ureum, 12-14 delen superfosfaat, 2,5-3,5 delen kaliumchloride, 4-6 delen  
5 onschadelijk molybdeenafval, en 1,5-2,5 delen humuszuur, en deze gelijkmatig mengen;

(3) Water toevoegen aan de bovengenoemde gemengde materialen om het vochtgehalte aan te passen tot 40%-60%, afdekken met plastic folie, en in afgesloten toestand opslaan gedurende 5-7 dagen;

10 (4) Verspreiden om te drogen of drogen tot het vochtgehalte  $\leq 10\%$  is, en verwerken tot korrelmeststof.

6. De verwerkingswerkwijze voor de organische samengestelde meststof gemaakt van residuen van traditionele Chinese geneeskunde voor verbetering van arme grond  
15 volgens conclusie 5, waarbij in stap (3) de opslagtemperatuur in de afgesloten toestand wordt gecontroleerd tot  $\leq 60^{\circ}\text{C}$ .

7. De verwerkingswerkwijze voor de organische samengestelde meststof gemaakt van residuen van traditionele Chinese geneeskunde voor verbetering van arme grond  
20 volgens conclusie 5 of 6, waarbij in stap (4) de droogtemperatuur wordt gecontroleerd tot  $\leq 70^{\circ}\text{C}$ .