

## PRACTICAL 5

### THEME : Calculation of vegetable oil production from non-traditional oilseeds

Producing oil from non-traditional seeds (e.g., sunflower, safflower, camelina, hemp, apricot kernels) follows the same basic principles as traditional seeds, but the extraction rates and oil quality vary significantly.

The core formula is simple:

**Total Oil Production = Quantity of Seeds × Oil Content (%) × Extraction Efficiency (%)**

Let's define the critical variables:

- **A. Oil Content (%):** This is the maximum amount of oil that can be theoretically extracted from the seed. It is determined by the seed's biology and is usually found in agricultural databases or through lab analysis (Soxhlet extraction).
  - *Examples:*
    - Sunflower: 35-50%
    - Hemp Seed: 25-35%
    - Safflower: 35-45%
    - Camelina: 35-40%
    - Apricot Kernel: 40-50%
- **B. Extraction Efficiency (%):** No method can get 100% of the oil out of the seed. The efficiency depends on the extraction technology used.
  - **Cold Pressing/Expeller Pressing:** The most common for small-scale, high-quality oil. Efficiency is typically **60-75%**. This means 25-40% of the oil remains in the press cake.
  - **Solvent Extraction:** Used industrially. It's highly efficient, around **95-99%**, but uses chemical solvents (e.g., hexane) and is not suitable for small-scale or "organic" labels.
  - **Supercritical CO<sub>2</sub> Extraction:** A high-tech, efficient (85-95%) method that produces very pure oil, but the equipment is extremely expensive.
- **C. Seed Processing Losses:** Before pressing, seeds are cleaned, dehulled, and sometimes roasted. This reduces the total mass going into the press.
  - **Hulling/Dehulling Loss:** Removing the shell/hull increases the oil concentration in the press material but reduces the total weight. The hull percentage must be accounted for.
  - **Moisture Content:** Proper moisture is needed for pressing. Too much or too little can reduce efficiency.

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## 2. Step-by-Step Calculation Method

Here is a practical, step-by-step guide to calculate your expected oil yield.

**Scenario:** Let's calculate the oil production from 100 kg of hemp seeds.

### Step 1: Determine Initial Seed Mass and Oil Content

- Initial Seed Mass = 100 kg
- Assume Hemp Seed Oil Content = **30%** (a common average).
- \*Theoretical Maximum Oil =  $100 \text{ kg} \times 0.30 = 30 \text{ kg}$ \*

### Step 2: Account for Pre-Processing (Hulling)

Hemp seeds are often hulled to improve oil quality and yield.

- Assume Hemp Seed Hull Percentage = **20%**
- Mass of Hulls =  $100 \text{ kg} \times 0.20 = 20 \text{ kg}$
- **Mass of Kernels for Pressing** =  $100 \text{ kg} - 20 \text{ kg} = 80 \text{ kg}$

Now, the oil is concentrated in the 80 kg of kernels.

- Oil in Kernels = 30 kg (all the oil was in the kernel, not the hull)
- *Effective Oil Content in Press Material* =  $(30 \text{ kg} / 80 \text{ kg}) \times 100 = 37.5\%$

### Step 3: Calculate Extractable Oil (Based on Efficiency)

We will use a cold press method.

- Assume Extraction Efficiency = **70%**
  - **Actual Oil Yield** = (Mass of Kernels × Effective Oil Content) × Extraction Efficiency
- =  $(80 \text{ kg} \times 0.375) \times 0.70$
  - =  $30 \text{ kg} \times 0.70$
  - = **21 kg**

### Step 4: Account for Filtration and Settling Losses

After pressing, the crude oil contains small solid particles (meal). Some oil is lost during filtration.

- Assume Filtration Loss = **2%**
- **Final, Bottled Oil Production** =  $21 \text{ kg} \times (1 - 0.02) = 21 \text{ kg} \times 0.98 = 20.58 \text{ kg}$

### Step 5: Convert to Liters (for bottling)

Oil is often sold by volume. You need the oil's density.

- Density of Hemp Seed Oil ≈ **0.92 kg/L**

- **Final Oil Volume = 20.58 kg / 0.92 kg/L = 22.37 Liters**
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### 3. Summary of Calculation

Step	Description	Calculation	Result
1	Theoretical Oil in 100kg Seeds	$100 \text{ kg} \times 30\%$	30 kg
2	Mass after 20% Dehulling	$100 \text{ kg} - 20 \text{ kg}$	80 kg
3	Oil from Pressing (70% Eff.)	$30 \text{ kg} \times 70\%$	21 kg
4	Oil after Filtration (98% Eff.)	$21 \text{ kg} \times 98\%$	20.58 kg
5	<b>Final Volume</b>	$20.58 \text{ kg} / 0.92 \text{ kg/L}$	<b>~22.4 Liters</b>

#### Overall Yield Calculation:

You started with 100 kg of seeds and finished with 20.58 kg of oil.

- **Overall Oil Yield (%) =  $(20.58 \text{ kg} / 100 \text{ kg}) \times 100 = 20.58\%$**

This is your most important business metric: **For every 100 kg of raw hemp seeds, you can expect to produce approximately 20.6 kg (or 22.4 Liters) of bottled, filtered oil.**

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### 4. By-Products: The Press Cake

The calculation isn't complete without considering the by-product, which can be sold to improve profitability.

- **Mass of Press Cake = Mass of Kernels - Oil Extracted**
  - o  $= 80 \text{ kg} - 21 \text{ kg} = 59 \text{ kg}$

- This 59 kg of press cake is rich in protein and retains the ~30% of oil that wasn't extracted (9 kg of oil). It is a valuable product for animal feed, protein flour, or fertilizer.
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## 5. Factors Influencing Your Actual Yield

Your actual numbers will differ. Key factors to test and monitor:

1. **Seed Variety and Quality:** Different cultivars of the same seed have different oil contents. Use high-quality, clean, dry seeds.
2. **Pre-Treatment:** Light roasting can break down cell walls and increase yield but may affect the "cold-pressed" label.
3. **Press Type and Settings:** The screw speed, choke setting, and temperature of your expeller press dramatically affect efficiency. A slower screw and tighter choke generally mean higher efficiency but more heat.
4. **Operator Skill:** Experienced operators can "feel" the press and adjust settings for optimal output.

## Conclusion

To calculate your oil production, follow this sequence:

**Final Oil (kg) = [ (Seed Mass × (1 - Hull %)) × Oil Content ] × Extraction Efficiency × (1 - Filtration Loss)**