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D2.1 Raw materials for protein fractionation

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Dissemination Level		
PU	Public	x
PP	Restricted to other programme participants (including the Commission Services)	
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CO	Confidential, only for members of the consortium (including the Commission Services)	

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 635727.

1. Introduction and Objectives

The aim of work package 2 is to design industrially applicable, and environmentally and economically sustainable techniques for targeted processing and fractionation of seeds from high quality protein seed crops (quinoa, amaranth and buckwheat) and legumes (lupin, faba bean and lentils) providing various food ingredients (flour, concentrates, isolates) with good functional and sensory properties targeted for the production of attractive and tasty food products with enhanced nutritional quality. For the fractionation of these raw materials and production of food ingredients dry milling (Task 2.1) as well as wet extraction methods (Task 2.2) will be investigated. A proper selection of raw materials is fundamental for both processing strategies.
D2.1 relates the selection and description of suitable raw materials for dry and wet protein fractionation studies.

2. Activities for solving the task

The selection of the raw materials was done in close cooperation with the project partners in WP1 and WP 3 and with the project coordinator. Corresponding discussions were part of workshops at the kick-off and the first annual meeting as well as subsequent conference calls with different raw material providers.
For the selection of raw materials the following criteria were discussed and taken into account:
- Availability of the seed in sufficient amount (from project partners or from the market)
- European origin of the seed (if possible)
- Use in the field trials in WP1
- Analytical data: Protein content, content of anti-nutrients

Based on these criteria varieties of each seed material were selected and analytically characterized. In addition the consortium agreed upon the types of ingredients which should be developed from each of the selected raw materials within the frame of WP2.

3. Results

As a result of the discussions in workshops and between individual partners in WP1 and WP2 the following cultivars were selected for the protein fractionation trials in WP2:

- Quinoa (*Chenopodium quinoa* cv. Titicaca)
- Amaranth (*Amaranthus caudatus* cv. Katia, + unknown material from India)
- Buckwheat (*Fagopyrum esculentum* cv. Cora, + commercial seed)
- Lupin (*Lupinus albus* cv. Dieta, *Lupinus mutabilis* ssp., *Lupinus angustifolius* cv. Boregine)
- Faba bean (*Vicia faba* cv. Divine, Colombo and Imposa)
- Lentil (*Lens culinaris* cv. Itaca)

The raw materials were provided either by project partners in WP 1 or purchased at local markets.

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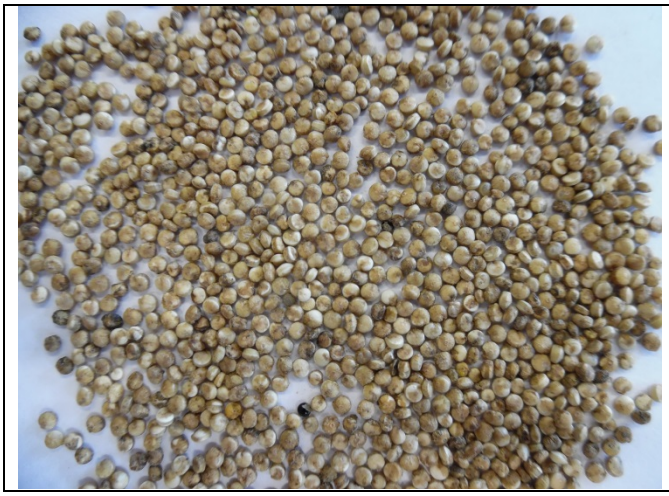
The characteristics of the selected raw materials are described in the following chapters 3.1 and 3.2. Chapter 3.3 gives an overview on the types of ingredients which are prospected to be developed during the frame of WP2.

3.1 Selected high-quality protein crops

Quinoa

For dry fractionation trials in the lab the quinoa variety "Titicaca" was selected. Titicaca is a Danish cultivar and was provided by the University of Copenhagen (Sven-Erik Jacobsen, UCPH-PLEN). The seed is from the 2014 harvest. The dry-fractionation trials on pilot-scale are based on commercially dehulled seeds of the same cultivar, which was purchased from Quinoa Marche, Italy. This is a result of the lab trials (see D 2.2), which have shown, that no proper dehulling is possible with the equipment at Fraunhofer. The analytical data of the used quinoa seed is shown in Table 1.

Table 1: Dry matter, protein, ash, fat and starch content of *Chenopodium quinoa* cv. Titicaca (data analysed in WP 2)



Dry matter [%]	92.6
Protein [%/DM]	15.6
Ash [%/DM]	2.9
Fat [%/DM]	7.9
Starch [%/DM]	54.8

Protein: N * 5.85 (according to Valcárcel-et al. 2012)

Amaranth

The lab trials in Task 2.1 started with *Amaranthus caudatus* cv. Katia, a cultivar selected and cultivated by the University in Kopenhagen (UCPH-PLEN). Since this variety was not available in sufficient amount for systematic milling trials a commercial seed of *Amaranthus caudatus* L. from India was selected for carrying out the dry fractionation trials on a pilot scale. The commercial seed was purchased at Teff-Shop.de, Bad Vilbel, Germany. Table 2 shows the analytical composition of both amaranth seeds.

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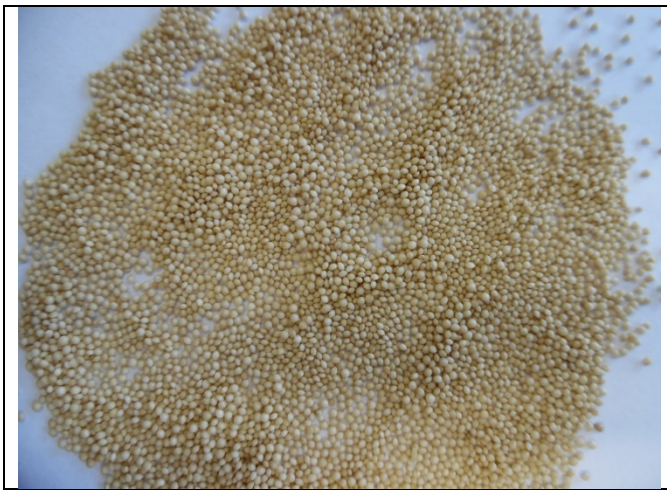
Table 2: Analytical composition of *Amaranthus caudatus* cv. Katia and a commercial amaranth seed used for protein fractionation in Task 2.1 (data analysed in WP 2)



	Katia	Commercial seed
Dry matter [%]	90.6	92.5
Protein [%/DM]	15.3	14.7
Ash [%/DM]	2.6	2.1
Fat [%/DM]	n.d.	7.5
Starch [%/DM]	n.d.	67.7

Protein: N * 5.85, (according to Valcárcel-et al 2012); n.d: not determined

Buckwheat

Dry fractionation in lab scale was based on *Fagopyrum esculentum* cv. Cora. This seed variety was selected and kindly provided by Ryszard Amarowicz from PAS in Olsztyn. As the lab trials showed that proper dehulling is not possible with the equipment at Fraunhofer the further trials for dry fractionation were carried out with dehulled buckwheat kernels. Dehulled buckwheat was purchased from Naturland Bauern AG, Hohenkammer, Germany. Table 3 shows the analytical composition of buckwheat cultivar “Cora” and the commercial dehulled seeds.

Table 3: Dry matter, protein, ash, fat and starch content of *Fagopyrum esculentum* cv. Cora and dehulled commercial seed (data analysed in WP 2)

	Cora	Commercial seed, dehulled
Dry matter [%]	91.6	90.4
Protein [%/DM]	14.3	15.5
Ash [%/DM]	n.d.	2.0
Fat [%/DM]	3.3	4.9
Starch [%/DM]	49.8	67.9

Protein: N * 6.25, n.d: not determined

3.2 Selected legume seeds

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Lupin

***Lupinus albus* cv. Dieta** is a certified seed. It is low in alkaloids and achieves high yields. Dieta is a strong crop with good lodging resistance and relatively low sensitivity to moulds and diseases. The crop can be harvested between half September and beginning of October. The height of the crop is 90-100 cm. Lupinus albus cv. Dieta was provided by MFH Pulses, NL. The seed is part of the field trials in WP1 and is used in WP 2 for dry fractionation (Task 2.1) and for protein extraction trials (Task 2.2) both on a lab and on pilot scale. The analytical composition of the seed is shown in Table 4.

Table 4: Analytical composition of *Lupinus albus* cv. Dieta (data analysed in WP 2)

Dry matter [%]	90.5
Protein [%/DM]	34.7
Ash [%/DM]	4.2
Fat [%/DM]	14.1

Protein: N * 5.7 (according to Sussmann et al 2013, Berghout et al. 2014)

With regard to the Andean lupin, ***L. mutabilis ssp.***, a small sample of locally grown commercial seeds from Peru was provided by the project partners at University La Molina, Lima. The seed is multi-varietal and is a bitter seed with around 1.8% of alkaloids and high protein content (47.2% after oil extraction). Therefore this seed will be used for lab scale protein extraction trials in order to prove the feasibility of protein recovery from this material.

In addition to the above mentioned lupin species, seeds of the blue lupin ***L. angustifolius cv.* Boregine** were selected as raw material for the pilot production of reference lupin protein isolate by project partner Prolupin. The average protein and fat contents of L. angustifolius “Boregine” are ranging from 28-31% and from 6-8% respectively (values are resulting from the analyses of several seed samples at Fraunhofer over the last years).

Faba bean

Three faba bean cultivars were selected for the trials in WP2. “Divine” a cultivar with a low content of vicin and convicin was used for the dry fractionation trials on a lab scale at Fraunhofer. “Colombo”, a Danish variety was selected by UCPH-FOOD for their protein extraction trials in lab scale. By the end of the first project year another cultivar, “Imposa”, was made available by the project partner LBI. Imposa is part of the field trials in WP 1 and is low in vicin/convicin and also low in tannins. Therefore it was decided in the first annual meeting to use the cultivar “Imposa” for

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the pilot scale trials of Task 2.1 and 2.2, which are planned to start from October 2016. The analytical composition of faba bean “Divine” is shown in Table 5. For the cultivar “Colombo” a lower protein content of 26.8% was determined. The data of variety “Imposa” are not analysed yet.

Table 5: Analytical composition of *Vicia faba* cv. Divine (data analysed in WP 2)

Dry matter [%]	89.5
Protein [%/DM]	31.6
Ash [%/DM]	n.d.
Fat [%/DM]	4.0
Starch [%/DM]	36.1

Protein: N * 6.25, n.d: not determined

Lentil

The lentil cultivar “Itaca” is one of the currently certified lentil seeds in Italy. The seed is part of the field trials in WP1 and was provided by project partner ISAFOM in cooperation with the Italian breeding company ISEA. Itaca is a brown lentil with orange kernels, which has average cold resistance and is resistant against drought and dehiscence. The analytical data are shown in Table 6.

Table 6: Analytical composition of *Lens culinaris* cv. Itaca (data analysed in WP 2)

Dry matter [%]	89.6
Protein [%/DM]	30.3
Ash [%/DM]	2.3
Fat [%/DM]	n.d.
Starch [%/DM]	42.8

Protein: N * 6.25, n.d: not determined

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Itaca is used as raw material for protein extraction trials in lab scale in Task 2.2. For the preparation of bigger amounts of flours in Task 2.1 as well as for pilot scale protein extraction there will not be enough seed available. Therefore another, commercially available, lentil seed has to be used.

3.3 Matrix of planned ingredients

The types of ingredients that have to be developed from the selected raw materials have been discussed and agreed upon in a workshop during the first annual meeting in February 2016 in Olsztyn, Poland. The resulting matrix of raw materials and corresponding ingredients is shown in Table 7. Flours from whole grains, from dehulled grains and protein-rich and protein-low fractions will be developed by dry milling and fractionation in Task 2.1. For providing protein isolates and protein concentrates wet processing methods will be applied in Task 2.2.

Table 7: Types of ingredients that will be developed within the schedule of WP2

	Products developed/provided by WP2 partners				
Grains	**Flour from whole grains**	**Flour from dehulled grains**	**Protein-rich flour**	**Protein-low flour**	**Protein isolate**
Quinoa		x	x	x	x
Amaranth	x		x	x	
Buckwheat		x	x	x	
White Lupin		x	x		x
Andean Lupin					x (only lab-scale)
Blue Lupin			x		x
Faba bean		x	x	x	x
Lentil	x	x			x

4. Conclusion and next steps

The selected raw materials form a good basis for lab scale trials for dry fractionation (Task 2.1) and protein extraction (Task 2.2). With regard to quinoa, lupin and faba bean the selected cultivars are also available in sufficient quantity for pilot scale processing to provide the ingredient amounts needed for food development in WP3. For pilot-scale processing of amaranth, buckwheat and lentil commercially available seeds will be used. More detailed analysis of the seeds including minor compounds will be carried out within the scope of Task 2.3 and corresponding results will be reported in D2.4.

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5. Delays and difficulties

Sample amounts of amaranth and faba bean provided by project partners were too low for systematic milling trials. Purchase of seeds of unknown origin on local market was necessary to allow milling trials.
Seeds of Andean lupin and lentils for protein extraction trials were delivered with several months delay and only in small amounts. Due to this only feasibility studies with these materials were possible. A general difficulty is the availability of sufficient quantities of the selected certified cultivars (> 200 kg) of amaranth, buckwheat and lentil for pilot scale processing. Therefore, commercially available seeds of these crops have to be purchased on local markets.

6. Impact and dissemination activities

The selected raw materials form the basis for the development of a number of new protein-rich food ingredients with good functional and sensory properties which are currently not available on the market. These ingredients can be used in WP3 for the development of innovative and tasty food prototypes with enhanced nutritional quality which are attractive for the consumers and have a viable market potential.

References

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