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In vivo germination of *Fagopyrum tataricum* (L.) Seeds an economically and medicinally important pseudocereal of Kashmir Himalaya

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Abstract
The genus Fagopyrum is represented by more than six species in Kashmir Himalaya belonging to family Polygonaceae. It is an important life support, multipurpose and nutritious crop of the tribes living in the Himalaya grown up to 4500m elevation. Besides *Fagopyrum esculentum* Moench., *Fagopyrum tataricum* (L.) Gaertn., *Fagopyrum saggittatum* Gilib. and *Fagopyrum Kashmirianum* Munshi are also being cultivated in the Himalayas. Currently the cultivation and production of buckwheat is declining and in some of areas, has been completely replaced due to change in land use pattern for quick economic gains. Tartary buckwheat grain- *Fagopyrum tataricum*, as an important functional food material, contains proteins with high biological value and balanced amino acid composition; relatively high crude fibre and vitamins B1, B2, and B6 and more Rutin than common buckwheat which tempted the author to carry out the detailed studies on Cultivation and Propagation of this species at low and high altitude. The parameters like germination percentage, seedling growth and plant height were studied.

Keywords: *In vivo, Fagopyrum tataricum,* Pseudocereal, Germination and Rutin

1. Introduction
The genus *Fagopyrum* (Buckwheat) a genus belonging to family Polygonaceae is native of Europe Asia, but most of the options concentrates on its origin being Central Asia. Buckwheat is one of the traditional crops cultivated in Asia, Central and Eastern Europe (Wijngaard and Arendt, 2006) [19]. It is categorized as a pseudocereal, so it shows both differences and similarities with cereals. Its seeds are edible and have triangular shape. Buckwheat does not have too massive root system, but its physiological activity is significant. Buckwheat roots excrete formic, acetic, citric and oxalic acids which help the plant to take nutrients, mainly phosphorus, from hard available forms. The stalks are hollow and their colour is green to red. Leaves stand alternately on the stalk. Buckwheat inflorescence is formed by 7 to 9 blossoms. They are tiny of white, pink or red colour (Janovská *et al*. 2009) [9]. The buckwheat fruit contains proteins, saccharides, lipids, fiber, vitamins and minerals as basic components. It is a source of dietary minerals like zinc, copper and manganese (Ikeda and Yamashita, 1994). It is also rich in dietary fiber which has a positive physiological effect in the gastrointestinal tract and also significantly influences the metabolism of other nutrients (Halbrecq *et al*., 2005) [6]. Buckwheat seeds contain no gluten so they are safe for people with celiac disease (Skerritt, 1986) [15]. Buckwheat can also act in the prevention and treatment of hypertension and hypercholesterolemia and it could be useful in preventing colon cancer. The preventive effect can be connected with the content of dietary fiber in buckwheat. It has become increasingly apparent that dietary fiber components in food may have a positive physiological effect in the gastrointestinal tract and also significantly influence the metabolism of other nutrients (He *et al*., 1995) [7]. In different parts of the buckwheat plant and groats, Watanabe (1998), Kreft *et al*. (1999) and Park *et al*. (2000) [18, 13] found appreciable amounts of rutin, a secondary plant metabolite that antagonizes the increase of capillary fragility associated with hemorrhagic disease or hypertension in man. It also decreases the permeability of the blood vessels and has an antioedema effect, reduces the risk of arteriosclerosis and has antioxidant activity. Rutin (quercetin-3-rutinosid) is a flavonol glycoside synthesized in higher plants as a protectant against ultraviolet radiation and diseases (Rozema *et al*., 2002) [14]. Among fruits, vegetables and grain crops, grapes and buckwheat are the most important rutin containing food. No rutin was found in cereals and pseudocereals except buckwheat, which can be used as a good source of dietary rutin (Hagels, 1999) [5]. Most rutin is accumulated in the inflorescence, stalks and upper leaves (Kreft *et al*., 2006) [11]. In India, the crop is widely grown in Jammu and Kashmir and Arunachal Pradesh in the east.

Its high concentration was observed in high mountains of Jammu & Kashmir, Leh, Himachal Pradesh, Garwhal, Kumaon, Darjeeling, Sikkim, Assam, Arunachal Pradesh, Nagaland, Manipur, Nilgiris, Palani hills (Joshi 1999) [10]. In Kashmir Himalaya the genus is represented by four cultivated species Viz., *F. saggittataum, F. tataricum, F. esculentum, F. kashmirianum* and wild species *F. dibortrys.* Several varieties cultivated in tribals areas of Kashmir Himalaya ranging from 6,000 to 10, 500 ft. have been collected at diverse place for present investigation. Some of the roadside localities were visited by vehicle include Telel, Drass, Jowdoor, Kargil and Ladakh.

1.1. *Fagopyrum tataricum* (L.) Gaertn. Description

Tartary buckwheat is a domesticated food plant in the genus *Fagopyrum* in the family Polygonaceae.With its congener common buckwheat, it is often counted as a cereal, but unlike the true cereals the buckwheat's are not members of the grass family. Thus they are not related to true wheat. Tartary buckwheat is bitterer, but contains more rutin than common buckwheat. It also contains quercitrin. Tartary buckwheat is domesticated in east Asia. While it is unfamiliar to the West, it is still eaten in the Himalayan region today.

2. Materials and Methods

The plant materials used in this study were different cultivars of buckwheat. Seeds of these cultivars were sown and cultivated in the experimental field at Kashmir University Botanical Garden (KUBG) (1590m altitude) and Sonamarg (2560m altitude) to the flowering stage (Table 2 and Table 3). The plot size was 2.0 x 1.5 m. Seeds were sown about 10 cm apart, in rows with 10 cm distance between them. Plant samples were taken at equal time intervals; about twenty plants per cultivar were collected to obtain enough sample material. Morphological characters were investigated at the early flowering stage for stem length, number of branches and number of leaves.

3. Results and Discussion

During the present *In vivo* studies some differences were observed regarding the seed germination and seedling growth of *F. tataricum* and the rest of the three species. As compared to a low percentage of seedling emergences in *F. tataricum* the other three species uniformly showed a high percentage of seedling emergences (Table 1). A higher percentage of seed germination and seed viability has been reported in *F. esculentum, F. saggittatum* and *F. kashmirianum* as compared to *F. tataricum*. It would appear that the massive hulls in *F. tataricum* restrict seed germination in this species. Our reports are in accordance to the findings of (Farooq and Tahir 1982; Tahir and Farooq 1983) [3, 17]. Buckwheat grows best in soils with light to medium texture and good drainage (Clark, 2007) [2] and will tolerate moderately acidic soils (to a pH of 5) (Myers and Meinke, 1994) [12]. It will not grow well in compacted, saturated, or coarse soils and is not tolerant of frost, flooding, soil crusting or extreme drought (Clark, 2007; Bjorkman and Shail, 2010) [2]. Buckwheat is better adapted to low-fertile soils than most other crops (Clark, 2007) [2] and often the residual nutrients from preceding crops are enough for adequate growth (Bjorkman *et al*., 2008) [1].

The appearance of first leaf in *F. tataricum* was somewhat delayed owing to a slower initial growth. The onset of flowering and subsequent grain formation occurred first in *F. esculentum* and last of all in *F. tataricum* is suggestive of the early flowering and early maturing character of *F. esculentum*. The growth span of *F. tataricum* extended over 13-14 weeks and formation of new grains continued during this period. However, relatively short growth period of 10-12 weeks, characterises the remaining three species. Thus a short growth span together with a relatively higher seed germinability and viability, quicker seedling growth and higher emergence potential under field conditions in *F. esculentum, F. saggittatum* and *F. kashmirianum* suggest higher seed vigour in these species compared to *F. tataricum* (Table 4). These observations largely support the assumption made by Gelmond (1978) [4] that seed vigour is particularly pronounced in short duration crops. In *F. tataricum*, grains shattered as they matured, a character regarded unsuitable for a cultivated grain crop. Moreover, all the four species studied here are characterized by an indeterminate growth habit, which restricts yield, since a sizable number of grains go waste at harvest, being at various stages of maturity.

Table 1: Percentage Germination of different varieties of Fagopyrum

S. No.	Variety	Germination after 10 days	Germination after 20 days
1	*F. saggittatum*	72%	80%
2	*F. esculentum*	65%	70%
3	*F. kashmirianum*	60%	65%
4	*F. tataricum*	45%	55%

Table 2: Morphological Parameters of fagopyrum *tataricum* at site A (Kashmir University Botanical Garden)

S. No.	Variety	No. of branches per plant	No. of leaves per plant	Plant Height (in cm)
1	*F. tataricum*	8	64	68
2		6	90	98
3		5	50	64
4		7	72	78
5		4	36	50
6		7	67	70
7		3	18	35
8		4	35	52
9		5	60	58
10		9	65	73
11		2	10	11
12		5	42	60
13		7	89	97
14		7	67	78
15		4	32	48
16		4	42	58
17		6	50	64
18		5	70	75
19		5	50	56
20		4	36	25
Mean		**5.35**	**52.25**	**60.9**

Table 3: Morphological Parameters of *Fagopyrum tataricum* at site B (Sonmarg)

S. No.	Variety	No. of branches per plant	No. of leaves per plant	Plant Height (in cm)
1	*F. tataricum*	2	5	20
2		2	8	15
3		2	6	21
4		3	11	15
5		5	16	24
6		6	16	29
7		5	13	26
8		6	23	37
9		4	10	11
10		2	5	24
11		3	9	14
12		2	6	32
13		2	5	20
14		2	5	24
15		7	38	55
16		3	9	18
17		3	10	21
18		4	9	22
19		2	6	17
20		5	15	26
Mean		3.5	11.25	23.55

Table 4: Stages of growth phases after germination

	Growth Stage	Sample	Days after Germination
Stage 1	Emergence	Whole plant	04
Stage 2	First pair of Leaf Formation	Whole plant	08
Stage 3	Bud show and leaf growth	Recently mature leaf (second)	15
Stage 4	Vegetative growth and leaf growth	Mature leaf	20
Stage 5	Flowering and no leaf growth	Mature leaf	30
Stage 6	Peak Flowering	Inflorescence	40
Stage 7	Start of Seed formation	Immature seeds	52
Stage 8	Seeds in milk/ dough stage	Immature seeds	62
Stage 9	Filled Seeds are brown	Mature brown seeds	75

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